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# ***JPRS Report***

# **Science & Technology**

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***USSR: Electronics &  
Electrical Engineering***

# Science & Technology

## USSR: Electronics & Electrical Engineering

JPRS-UEE-90-002

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### Auxiliary Signal Recording in Video Tape Recorders

18620127a *RADIOTEKHNIKA in Russian*  
No 1, Jan 89 pp 5-7

[Article by Ye. K. Tarygin, I. V. Fridlyand]

[Abstract] This article analyzes the techniques used to record auxiliary signals such as audio signals in video tape recorders. The article estimates the noise immunity of the auxiliary channel for application to video recording equipment and derives a relation used to determine the possibility of recording an auxiliary signal in a video tape recorder by displacement of traveling heads perpendicular to the axial line track. The estimate of the signal-to-noise ratios of the chrominance signal and the signal-additive noise revealed that the effect of additive noise is less substantial in reproducing the auxiliary signal than is the effect of interference from the chrominance signal. The calculation reveals that since the chrominance signal interference is so strong, the auxiliary signal spectrum must be designed so that the signal components do not have a significant effect on its harmonics.

### Foil Resistor Components: Thermistors, Heaters, and Sensors

18620132c *Moscow PRIBORY I SISTEMY*  
*UPRAVLENIYA in Russian* No 1, Jan 89 pp 17-18

[Article by G. A. Frank]

[Abstract] This article discusses the general state of foil technology and its applications in electronic engineering to thermistors, heaters, and sensors. The article discusses the priority given to foil technologies in the Soviet Union and the fact that such technologies are being adopted on an increasing scale in the west. A general survey of the primary resistor component designs are given; the four primary directions include foil thermistors, foil thermistors used in conjunction with digital instruments; gas and liquid flowmeters based on foil thermistors; foil heaters; and thermistors used in domestic products. The primary foil thermistor design employs a thermally-sensitive foil .003-.01 mm in thickness applied to a substrate (a dielectric or metallic substrate with an insulation layer). The TRP2-1 foil thermistor designs used for atmospheric temperature measurements employ a PM-1EU polyimide film 0.015 mm thick, an MP1 nickel foil 0.05 mm thick, and wire pins .6 mm in diameter. High-temperature foil thermistor designs employ metals, ceramics, glass-cements, and the N50K10 nickel-cobalt foil which has a linear temperature dependence up through 500°C. The article also provides comparative characteristics of thermistors of both Soviet and foreign manufacture. The primary specifications of air and fuel flowmeters and flow gauges employing thermistors are also provided.

### A Semiconductor Thermistor and its Characteristics

18620132d *Moscow PRIBORY I SISTEMY*  
*UPRAVLENIYA in Russian* No 1, Jan 89 pp 18-19

[Article by T. S. Grigorash, Yu. V. Zaytsev, V. V. Privezentsev]

[Abstract] This article analyzes the performance and operating principles of a semiconductor thermistor consisting of a 2.4 x 1.6 x 0.18 mm zinc-compensated silicon wafer; this wafer was diffusion-annealed in zinc vapors at excess pressure levels. The thermistor was then installed in a circuit consisting of a 10-12 V d.c. power supply and a 2-1 megaohm load resistor in series. The critical electrical field strength above which oscillations are excited is 10-20 V per cm with the threshold oscillation frequency at 10 to  $2 \times 10^3$  Hz. The article reports the primary functional parameters of the thermistor, including sensitivity, frequency temperature coefficient, and sensitivity threshold. One differentiating feature of this thermistor is its high temperature resolution. Possible applications of the device include a precision thermometer, a temperature imbalance sensor for temperature stabilization in thermostats and for temperature compensation for various components in electrical circuits.

### A Temperature Sensor/Fire Alarm Based on Quick-Response Thermistors

18620132e *Moscow PRIBORY I SISTEMY*  
*UPRAVLENIYA in Russian* No 1, Jan 89 pp 19-20

[Article by V. I. Zakharov, S. V. Mikhaylov]

[Abstract] This article discusses a temperature sensor/fire alarm design which detects combustion from fluctuations in convective flux temperature. This design responds to the variable component of temperature fluctuations within a specific frequency range as well as elevated amplitudes of temperature oscillations amounting to tenths of a degree; it also is resistant to false alarms resulting from interfering factors produced by operating electrical equipment (heaters, fans, etc.). Compact bead- and film-type thermistors were found to most fully satisfy the requirements of the sensor elements used in the fire alarm. The dynamic parameters of the thermistor designs (the ST3-25, ST3-18, TR-5, and the laboratory specimens) are reported. The temperature-to-voltage converter in the fire alarm is based on a K284UD1A operational amplifier while a sensor is used in the feedback circuit to transmit frequencies up to 3 Hz and allowing an amplitude-frequency response decay at the edge of the band of 3 dB. The sensitivity of the converter is 100 mV per °C<sup>-1</sup>. The comparative tests confirmed the excellent function of the experimental prototype and demonstrated a reduction in fire outbreak protection compared to existing popular fire alarms.



**Interpolator for Kudryavtsev [UW3DI] Transceiver***18620134a Leningrad FIZIKA TVERDOGO TELA  
in Russian Vol 31 No 2, Feb 89 pp 21-23*

[Article by G. Shulgin]

[Abstract] This article discusses the design and application of a special-purpose interpolator designed for use in conjunction with the transceiver designed by Yu. Kudryavtsev [UW3DI]; this transceiver is used by many Soviet DX-ers. This unit is used to receive signals in a 500 kHz bandwidth independent of the transceiver tuning frequency. Moreover, the high linearity and sensitivity of the unit make it possible to increase the dynamic range of the receiver section of the transceiver by a factor of 2 to 3 depending on the receiver tuning. Signals from two different stations can be received simultaneously with proper switching even when the stations are located at different ends of the frequency band. The interpolator functions as a receiver operating between 6 and 6.5 MHz with subsequent downconversion to 500 kHz. The unit can be used with both tube-type and tube-semiconductor UW3DI transceivers. A narrowband (telegraph) electromechanical filter can be connected to the unit; this improves the receiver selectivity and noise immunity. The excellent isolation between the master oscillator and the load assures that the use of an electronic digital scale will have no effect of receiver frequency stability. It also eliminates the requirement to have an additional receiver in constant operation at the radio station.

**Amateur Radio Scanner***18620134b Leningrad FIZIKA TVERDOGO TELA  
in Russian Vol 31 No 2, Feb 89 pp 24*

[Article by B. Chizh]

[Abstract] This article discusses the design of a scanner used for master oscillator frequency scanning in an amateur radio transceiver. The unit is used in a tube-transistor transceiver design. The scanner is based on transistors and operational amplifiers (a follower and a comparator). The scanner produces an output negative sawtooth voltage. A potentiometer is used to regulate the amplitude of the sawtooth voltage from zero to 27 V thereby altering the scanning range. The maximum scanning range is 50 kHz. Several different operational amplifiers can be used in this design including the K140UD7, K140UD8, KM140UD20, K157UD2, KR1005UD1, etc. Any transistors from the KT361, KT3107, KT502, etc. series can be used for the transistors.

**A Simple High Performance Audio Power Amplifier***18620134c Leningrad FIZIKA TVERDOGO TELA  
in Russian Vol 31 No 2, Feb 89 pp 44-48*

[Article by Ye. Gumel]

[Abstract] This article reports the development of a high-performance audio power amplifier for use in amateur radio applications. This audio amplifier design, which

employs amplifiers of a previous design, utilizes an operational amplifier in small signal conditions, which expands the frequency band of signals reproduced without increasing the rate of rise in the output voltage from the operational amplifier. The transistors in the output stage are configured in the common emitter configuration, while the preamplifier transistors are in a split load configuration in the emitter and collector circuits. Aside from the obvious design advantages the latter configuration allows placement of all four transistors on a common heat sink and provides certain advantages compared to an output stage in which the transistors are in a common collector configuration [2]. The specifications of the audio power amplifier include: nominal frequency range for an amplitude-frequency response nonuniformity of 2 dB, Hz: 20-20,000; nominal (maximum) output power, W, into a load of resistance, ohms: 4: 30(42), 8: 15(21); coefficient of harmonic distortion at nominal power level, %, less than: 0.01; input impedance, kohms: 47; output impedance, ohms, less than: 0.03; relative noise and background level, dB, less than: -86.

**The "Elektronika VM-12" Video Cassette Recorder***18620134d Leningrad FIZIKA TVERDOGO TELA  
in Russian Vol 31 No 2, Feb 89 pp 50-55*

[Article by A. Bondarenko, A. Krylov]

[Abstract] This article discusses the design, performance and specifications of the tuner section of the "Elektronika VM-12" video cassette recorder of Soviet domestic manufacture. This unit detects and amplifies television broadcast signals when the video cassette recorder is in a "record", "rewind", and "stop" mode. In the "playback" mode the unit generates RF signals modulated by the video and audio signals of the broadcast program and transmits these signals to the television. The tuner itself consists of a receiver section and a transmitter section. The receiver section receives VHF television signals as well as the accompanying audio signals for recording purposes. The unit contains an antenna distributor, selector, RF channel, and television program selection units. The transmitter section converts the video and audio signals produced from the magnetic tape to channels 6 or 7 in the VHF range and provides continuous tuning from channel to channel. The specifications of the tuner include: current consumption, mA, from voltage sources, V: +12 (excluding the antenna distributor): 200; +12 (including the antenna distributor): 85; +18: 4; +45: 8; -13: 3; output voltage range of composite television signal into a 75 ohm load, V: 0.7-1.3; maximum input signal level, mV, greater than: 87; coefficient of nonlinear distortion of television signal, %, less than: 15.

### Compact Radio Broadcasting Receiver

18620134e Leningrad FIZIKA TVERDOGO TELA in Russian Vol 31 No 2, Feb 89 pp 56-59

[Article by I. Malishevskiy]

[Abstract] This article discusses the development of a portable radio broadcast receiver consisting of a pocket tuner and an audio frequency amplifier. The tuner receives signals in the longwave and medium wave bands and reproduces the signals through a TM2-A headset. The audio frequency amplifier amplifies the signals from the tuner and reproduces the signals using an 0.5GD-21 speaker. The tuner is powered by a single 316 battery, while six batteries are used with the audio amplifier. The tuner can operate at voltage drops to 1.15 V. The tuner is a superhet unit employing ten transistors. Its RF section consists of a magnetic antenna, front-end circuits, a frequency converter with a separate master oscillator, a three-stage IF amplifier, a transistor detector, and an audio amplifier. The tuner transistors can operate at microcurrents of 5-15 microamps.

### Cable TV Today and Tomorrow

18620158a Moscow ELEKTROSVYAZ in Russian No 2, Feb 89 pp 1-3

[Article by R. Levin]

[Abstract] This is a published interview of A. I. Kushtev, First Deputy General Director of the "Radio" Scientific and Industrial Association conducted by "Elektrosvyaz" [Telecommunications] correspondent R. Levin. The interview covers the period extending from the first collective television cable systems appearing in Moscow in 1952 through the present 2000-10,000 subscriber distributed systems in operation in large Soviet cities as well as future developmental prospects of the domestic cable industry in the Soviet Union. The article discusses the early developments of collective-use cable systems which were subsequently followed by collective-use distributed cable systems where subscribers are fed by a single receiving station with an antenna free of obstacles. At present, the design, assembly, alignment, and maintenance of cable television systems in Moscow are under the direction of the USSR Ministry of Communications. At present plans are in place to convert the many different local cable television systems which are based on incompatible designs into large-scale collective-use distributed cable systems by the year 1995. A general design has been developed and design documentation is currently being drafted for such systems. The article discusses in some detail the distribution of design, construction, alignment, and maintenance functions among the local and union ministries.

### Modern Television Reception Networks in Large Cities

18620158b Moscow ELEKTROSVYAZ in Russian No 2, Feb 89 pp 4-5

[Article by A. L. Kanevskiy]

[Abstract] This article traces the history of development of the television receiver network over the last 20 years and identifies its areas of future development. The analysis is based on the experience of the Moscow network. The article outlines four specific stages of development of the domestic television receiver network in the Soviet Union: 1) utilization of individual outdoor receiver antennas (from the beginning of television broadcasting to the mid-1950s); 2) the comprehensive utilization of collective television reception systems with up to 100 subscribers per system (from the mid-1950s to the early 1970s); the introduction of large-scale two-stage collective-use distributed networks in large cities covering up to tens of buildings and up to 5000 subscribers (from the mid-1970s to date); and 4) the incorporation of cable television systems which provides high-quality television broadcasting and radio programs to tens of thousands of subscribers as well as other forms of information from receive antennas to subscribers and vice versa (available from the mid-1980s). The present plans are for development of an integrated large-scale cable television system based on a common, shared technology to replace the extensive variety of collective-use and distributed cable systems existing in Moscow today; there are hundreds of such systems each handling from a few thousand to tens of thousands of subscribers each. The design plans, measures for improving system reliability and integrating the various networks are discussed in detail.

### Problems in the Development of Cable Television Systems in the USSR

18620158c Moscow ELEKTROSVYAZ in Russian No 2, Feb 89 pp 17-19

[Article by L. Marinin]

[Abstract] This article reports the proceedings of the All-Union Scientific and Technical Conference "Cable Television Systems and System Maintenance" held in Moscow at the All-Union Transmission Station in October of last year. Three hundred specialists attended the conference which was convened in order to develop a clear program of action for incorporating cable television systems, and to provide a meeting place for sharing opinions between specialists of the various organizations involved in the process and for municipal authorities working in cable television development. Twenty-six papers were read at the conference; these papers dealt with the current status of the television receiver network, the development of the technical base of television broadcasting, and large-scale collective-use distributed cable systems, the design and experience of constructing large-scale collective-use cable systems, the application

of fiber-optic communications links to collective-use cable systems, the design of test instruments and measurement equipment and antennas, as well as documentation and specifications for such systems.

#### **The Problems of Incorporating Fiber-Optic Transmission Systems: A Subject of Special Interest to Communications Specialists**

18620158d Moscow ELEKTROSVYAZ in Russian  
No 2, Feb 89 pp 20-21

[Article by I. Kovaleva]

[Abstract] This article reviews the existing fiber-optic transmission systems in place in the Soviet Union as well as the types of optical cables manufactured for internal zone communications, the specifications and performance of such systems, the tools and instruments for optical fiber welding, the various test equipment used in supporting maintenance and operations such as optical testers, voltmeters, generators, etc. together with the organizational and technical problems of expanding the use of fiber-optic transmission systems and the use of new communications hardware on the Unified Automated Communications Network. The article sites specific measures for accelerating the development and incorporation of both fiber-optic transmission systems and fiber-optic cables in the Integrated Automated Communications Network. Measures proposed by the USSR Ministry of Communications and the Union Republics are also reviewed.

#### **Optical Communications Cables for Municipal Telephone Networks**

18620158e Moscow ELEKTROSVYAZ in Russian  
No 2, Feb 89 pp 22-23

[Article by N. V. Galkina, S. M. Novokhatko, L. G. Rysin]

[Abstract] This is a brief review article of the design features of optical communications cables. The use of optical fibers and cladding techniques for transmission of signals on optical fibers are discussed together with the primary differences in design between fiber-optic cables and standard copper cables. Measures to reduce cable size and weight in the construction and installation of fiber-optic cables are discussed. The article notes that the primary element in the design of such cables is the proper selection of optimum structural materials having different coefficients of linear expansion accounting for the anticipated operational temperature range of the cables. In designing fiber-optic cables for municipal telephone networks several factors are taken into account such as compatibility with the protective cladding materials, functional capacity within the operational temperature range, ease of manufacture of the materials and the cable assembly process, and safety aspects. The article provides the dimensions for the structural elements of the OK-50-2-3-8 municipal telephone network fiber-optic communications cable.

#### **Initial Research on Optical Multichannel Communications. A Survey Devoted to the 30th Anniversary of Early Research**

18620158f Moscow ELEKTROSVYAZ in Russian  
No 2, Feb 89 pp 28-33

[Article by V. N. Kuzmichev, V. I. Makkaveyev]

[Abstract] This is a survey article of the 30 year history of research and development in fiber-optic communications technology. This history is divided into two stages: prior to and subsequent to the development of lasers. The initial period dates back to 1957 when O. F. Kosminskiy and V. N. Kuzmichev of a Leningrad Scientific Research Institute conducted initial research on the use of optical radiation for transmitting large volumes of information and were the first to consider possible designs of multichannel long-range communications systems employing light rays. The principles underlying the solid-state laser were developed by N. G. Basov and N. A. Prokhorov in conjunction with Charles Townes, the American scientist. Early studies applied the same principles of multichannel transmission systems to optical systems. Designs specifically suited for transmission of coherent optical radiation were subsequently developed. Early designs employed hollow optical fibers, which were followed by an optical beam waveguide and, finally, optical fibers for data transmission. The study contains a detailed review of early research and researchers involved in the experimental design, fabrication, testing, installation, and maintenance of fiber-optic communications links and transmission systems.

#### **The "IKM-120-4/5:" A New Digital Transmission System for Municipal Telephone Networks**

18620158g Moscow ELEKTROSVYAZ in Russian  
No 2, Feb 89 pp 33

[Article by unidentified author]

[Abstract] This article discusses the development of the "IKM-20-4/5" secondary digital transmission system designed for use with balanced RF and fiber-optic communications cables in municipal telephone networks employing both one- and two-cable line circuit transmission techniques. This equipment can be used to generate 120 voice grade frequency channels by synchronous (asynchronous) or by combining four primary digital streams at transmission speeds of 2048 kbits per second or 90 voice grade frequency channels by synchronous (asynchronous) combination of a standard 60 channel analog signal converted into digital form combined with a single 2048 kbit per second digital stream. State performance tests on the "IKM-120-4/5" conducted at the Moscow and Leningrad municipal telephone networks reveal that the equipment largely meets the technical design specifications. The exceptions include noise immunity, resistance to phase drift of the input signals from the OLT-21 unit and certain parameters of the ATSO-21 unit.

### **The "Moskva-Globalnaya" Satellite Television System for an Expanded Service Region**

18620171a Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 3-10

[Article by Yu. B. Zubarev, L. Ya. Kantor, B. A. Lokshin]

[Abstract] This article is devoted to a discussion of the design, specifications, and coverage of the "Moskva-Globalnaya" ["Moscow-Global"] satellite television system. This system represents the next stage in the development of the distributed "Moskva" ["Moscow"] system and uses the high-power downlink of the "Gorizont" ["Horizon"] satellite. The "Moskva-Globalnaya" system employs a global-coverage antenna which illuminates the entire terrestrial surface visible from the satellite, unlike the narrow directional pattern of the "Moskva" system. The "Gorizont" satellites used in the system are in geostationary orbits at 11° western longitude and 96.5° eastern longitude, thereby providing substantial coverage. In addition to television pictures, this system also transmits television sound pictures, broadcasting signals and digital data signals. Standard voice-grade frequency channels with multiplexing capability are provided to customers interested in digital data transmission on the system such as TASS and other organizations with foreign offices. In addition to block diagrams of the system configurations, the article also reports the specifications for the television picture channel, the television audio and sound broadcasting channels, and voice-grade frequency channels. A brief discussion of electromagnetic compatibility is given.

### **Prospects for the Development of Digital Radio Broadcasting in the USSR**

18620171b Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 10

[Article by unidentified author]

[Abstract] This article is devoted to a review of the current status of discussions regarding digital radio broadcasting in the USSR. The Scientific and Technical Council of the USSR Ministry of Communications conducted a session in June of 1988 to hear a paper entitled "The Development of Issues in Digital Radio Broadcasting in the USSR." The "Comprehensive Program for Development and Implementation of Experiments Devoted to Digital Radio Broadcasting" was a subject of discussion in this paper and multiple technical proposals from various organizations were also discussed in the course of the conference. Certain principles of digital radio broadcasting were identified as both desirable and ideal for implementation. These include complete coverage of the territory during the broadcasting period and the capability of fixed, portable, and car receivers to receive the programs with unidirectional antennas together with complete compatibility of program channels, transmitters, frequency bands, and transmission techniques for fixed and mobile radio communications

and topologic compatibility between the digital radio broadcasting and both the expanding and existing FM and television broadcasting network. The article also recommends developing effective techniques and algorithms for reducing the digital flow for audio signal broadcasting as well as developing and introducing a unified low-speed digital broadcasting signal format for both the primary and secondary distribution networks.

### **Twenty-Four Hour Radio Communications at a Fixed HF Frequency**

18620171c Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 14-17

[Article by R. G. Minullin, V. I. Nazarenko, R. Z. Syunyaev, O. N. Sherstyukov]

[Abstract] This article reports experiments conducted on a Moscow-Kazan route 700 km in length between July and August of 1979, December and January of 1980 and July and August of 1983 to determine HF radiowave propagation conditions and variations in signal amplitude during propagation. HF radio transmitters operating at 5, 10 and 15 MHz were used in the experiments. Transmitter power varied from 10 to 20 kW with receiver sensitivities of 0.1 mcV for a 200 Hz bandwidth. Unidirectional antennas were used for the transmitters and a broadband vertical unbalanced dipole 10 m in height with a circular directional pattern in the horizontal plane was used for reception. It was determined from these tests that when the propagation route parameters remain unchanged near-24 hour transmission of information at a fixed frequency is possible even in the worst signal propagation conditions with a detection threshold of 1 mcV, a throughput capacity of 200 bits per second and a communications reliability of 90 percent. It is necessary to use the statistical properties of the received signal amplitude and to know the preferential periods of various radiowave propagation methods in order to increase the information transmission speed and communications reliability.

### **A Digital Multifrequency "Two-of-Six" Code Receiver**

18620171d Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 30-32

[Article by A. V. Brunchenko, A. Ye. Sedov]

[Abstract] This article discusses the circuit design principles and provides an analysis of a receiver used to detect harmonics at 700, 900, 1100, 1300, 1500, and 1700 Hz in PCM digital communications networks. Various "two-of-six" combinations of these components are used to transmit control signals in automatic telephone communications systems, primarily for transmitting subscriber numbers. The optimum amplitude-frequency responses for the system are calculated as well as proper automatic gain control levels for the unit. A 16-channel receiver prototype containing approximately 150 CMOS medium-scale integrated circuits in addition



to a multiplier based on transistor-transistor logic circuitry was developed. The unit consumed less than 2.5 W in operation.

### **Optimum 3B2T Relative Bipulse Signal Generation Algorithm for Application to Subscriber Line Digital Transmission Systems**

18620171e Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 35-37

[Article by B. N. Maglitskiy]

[Abstract] This article proposes a 3B2T signal transmission algorithm that employs a relative bipulse signal and evaluates the possibility for the application of such an arrangement to subscriber line transmission systems. Two-stage 3B2T relative bipulse signal generation algorithms are analyzed in order to optimize the spectral power density of the signal. Calculation results for the normalized spectral power density are given for different 3B2T relative bipulse signal implementations. It is determined that a 3B2T relative bipulse signal in which the ternary "zero" in the second conversion stage is represented by a block of equipolar pulses has a lower concentration of RF spectral components than other signal variants. The 3B2T relative bipulse signal generation algorithm proposed in this study will therefore produce fewer RF spectral components compared to other variants; such 3B2T relative bipulse signals can be used in the line circuits of digital RF subscriber line equipment to increase subscriber line utility.

### **A Comparison of Telephone Signal Models for Distortion Analysis in a Standard PCM Digital Transmission System Coder**

18620171f Moscow ELEKTROSVYAZ in Russian  
No 11, Nov 89 pp 37-39

[Article by Derd Reti]

[Abstract] This article compares various models of telephone signal transmission quality in PCM digital transmission systems in order to determine the possibility for using such models to estimate noise contributed by a standard codec to the PCM telephone channel in a digital transmission system. The models considered in this analysis include the Davenport model which describes the probability distribution density of the instantaneous speech signal values by a specific function where the distribution parameters were selected by Davenport selectively; the Richards statistical model of a speech signal as a gamma distribution and the Velichkin model which proposes the sum of normal distributions of the vowels and consonants. In order to compare the experimental and normalization models this analysis carried out calculations of quantization and overload noise protection levels as a function of coder input signal levels. Calculations revealed that the quantization and overload levels depended on both the coder input signal level and the model of the distribution of signal values utilized in the analysis. The input signal peak-factor was

found to have the strongest effect on the spread of the noise characteristics. The study concludes that the peak factor of a pseudonoise test signal must be equal to 10.5 dB in accordance with CCITT Recommendation 0.131; this allows measurement of the quantization and overload noise curve to approximately -7.5 dBmO.

### **The "Elektronika VM-12" Video Cassette Recorder**

18600190b Moscow RADIO in Russian  
No 3, Mar 89 pp 33-39

[Article by A. Fedorchenki]

[Abstract] This article includes a detailed functional circuit analysis of the luminance channel in the "Elektronika VM-12" video cassette recorder. A complete schematic of the luminance channel is provided together with plots of the line sync pulses, the black limiting level, and the white limiting level. A comprehensive signal trace through the various circuitry comprising the luminance channel is provided together with a detailed description of the automatic gain control network. Also given are the pulse sequences at the detector output, the signals in the amplification channel of video recording heads a and b, switching pulses, the output signals from amplifiers a and b, and the signals after addition and equalization.

### **To "Korvet" Users**

18600190c Moscow RADIO in Russian  
No 3, Mar 89 pp 43-46

[Article by S. Akhmanov, N. Roy, A. Skurikhin]

[Abstract] This article is a continuation of a series devoted to the "Korvet" [Corvette] system users. This segment is devoted to the RAM and the graphics display capabilities of the system. The "Korvet" system has a 350 kilobyte memory capacity: 96 kb are assigned to the ROM while 257 kb are occupied by the RAM. The RAM is divided in the following manner: 64 kb for the microprocessor RAM; 192 kb for the graphics display RAM, and 1 kb for the alphanumeric display memory. The "Korvet" system also includes a memory dispatcher in order to make it possible to utilize such memory which has only 16 address lines. The memory dispatcher generates signals that allow access to various RAM areas. This is called the page mode. The minimum page capacity in this system is 256 bytes and is expandable; maximum page parameters are not strictly limited. The article also provides a block diagram of the alphanumeric and graphics displays. The article discusses in detail various advantages of the page mode, techniques for utilizing available memory, the process for accessing the video memory, and the alphanumeric display.



### **Magnetic Tape Standard for Domestic Audio Recording**

18600190d Moscow *RADIO in Russian*  
No 3, Mar 89 pp 55-56

[Article by Yu. Kozyurenko, A. Melnikov]

[Abstract] This article proposes a new standard for functional specifications and performance of audiomagnetic tape. Soviet industry presently manufactures the MEK I and MEK II audio magnetic tapes for domestic consumption with the MEK IV to be manufactured in the near future. The new standard outlines the acoustic parameters of reel-to-reel and cassette tapes for domestic audio applications. Such specifications as the relative sensitivity, sensitivity nonuniformity, maximum recording level, maximum recording level at 10,000 Hz, signal-to-noise ratio, signal-to-echo ratio, erasability, etc. are provided. The new standard also imposes more stringent requirements on tape abrasion levels. The new standard also outlines new low-level parameters, i.e., designers and manufacturers of magnetic tapes cannot manufacture tapes with specifications below these levels. The Specification is consistent with International Electrotechnical Commission publication 74, part 5.

### **Electronic Multibeam Projection Tubes for Collective-Viewing Television Receivers**

18600268a Moscow *TEKHNIKA KINO I*  
*TELEVIDENIYA in Russian* No 7, Jul 89 pp 23-30

[Article by O. A. Lyubich, N. G. Romyantsev]

[Abstract] This article discusses the advantages of using electronic multibeam projection tubes over standard projection beam tubes for collective viewing television

receivers. In addition to schematics the study provides graphs of the variation in screen luminance as a function of the total beam current for multiple beams and a single beam as well as other relevant visual specifications (modulation characteristics, variation in current load density, and variability in light beam width at half amplitude). The specifications of both ordinary projection beam tubes and electronic multibeam projection tubes are provided.

### **Chromaticity Measurement Error from a Photoelectric Colorimeter**

18600268b Moscow *TEKHNIKA KINO I*  
*TELEVIDENIYA in Russian* No 7, Jul 89 pp 30-32

[Article by A. K. Kustarev]

[Abstract] This study examines chromaticity measurement error resulting from imprecise spectral matching for a four-channel colorimeter utilizing the XYZ system developed in 1931 by the International Commission on Illumination; the two branches of the intensity versus frequency curves are implemented in two different channels. The study identifies the regions of maximum chromaticity variance for the case of measurement by the four-channel colorimeter whose spectral sensitivity characteristics differ from the sum functions within a given range. The study concludes that the chromaticity coordinate measurement errors will always be different for different chromaticities. Therefore the ordinary variability factor of plus or minus A percent can only be considered a rough approximation, yielding average values.

### The Influence of Spatial Parameter Estimation Accuracy on the Noise Immunity of Reception of Several Binary RF Signals

18620127b *RADIOTEKHNIKA in Russian*  
No 1, Jan 89 pp 10-11

[Article by A. S. Popov]

[Abstract] This article develops a method for analyzing the case of binary signal reception from two correspondents by a multielement antenna array; the method yields exact analytic relations for calculating the error probabilities of the joint reception of nonorthogonal signals of several correspondents as a function of the spatial parameters of the received signals, inaccuracies in signal estimates and the geometry of the antenna array.

### Traveling Wave Antenna with a Near-Axial Radiation Pattern

18620127f *RADIOTEKHNIKA in Russian*  
No 1, Jan 89 pp 58-61

[Article by V. G. Kocherzhevskiy, N. L. Lazarov, V. V. Shkvarin]

[Abstract] This article proposes a class of rather simple amplitude-phase distributions that make it possible to obtain an enhanced directivity in a given operating condition and also provides a method of practical implementation of these distributions. The study derives equations for the amplitude-phase distributions and carries out an experimental investigation of antennas producing such distributions using an antenna prototype generating experimental directional patterns at frequencies of 8000 MHz, 9370 MHz and 10,000 MHz. The calculated directional pattern of this antenna is given. The experimental results suggest a rather broadband response of the proposed antenna. The gain at the calculated frequency was 23.8 dB with a traveling wave coefficient in the feed line of better than 0.85 across the entire frequency range. The amplitude distributions proposed in this study yield an enhanced antenna directivity in a near-axial radiating mode. These distributions can be implemented by means of ribbed impedance structures.

### Application of Memory Functions to Calculation of the Rotational Absorption Spectrum of Water Vapors

18620136a *Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 1, Jan 89 pp 13-20

[Article by Yu. P. Kalmykov, S. V. Titov]

[Abstract] This article attempts to provide a more adequate description of the rotational absorption spectrum of water vapors based on memory functions widely and effectively used in nonequilibrium statistical thermodynamics, including dielectric relaxation theory. A model is derived that explains certain anomalies in the spectral

relations of the dielectric parameters in the microwave band. The model accounts for the primary molecular dynamical processes in gases (in a first approximation), including the near free rotation between collisions and the collision processes themselves. Molecular rotation is described in the derived equation by a Bloch-constant memory function. The model also accounts for the fact that the molecules experience free rotation interrupted by random collisions and following the collisions the momentum and projection of the momentum on a specific axis of the laboratory frame adopt a new value with a probability proportional to a Maxwellian distribution. The molecular orientation remains unchanged in this case. The model proposed in this study makes it possible to enhance the description of the microwave absorption spectrum of water vapor in normal atmospheric conditions.

### Surface Magnetostatic Wave Reflection off Ferrite Film Surface Irregularities

18620136c *Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 1, Jan 89 pp 41-46

[Article by Yu. I. Bespyatykh, I. Ye. Diksheyn, A. D. Simonov]

[Abstract] This study calculates the coefficient of reflection of surface magnetostatic waves off a one-dimensional surface irregularity tangential to a magnetized film with random orientation of the irregularity with respect to the magnetization field. The study identifies a strong dependence of the reflection coefficient on the magnetization field and the direction of incident wave propagation in the film plane which is attributed to the anisotropy and nonmutuality of the surface magnetostatic waves and the presence of a static demagnetization field near the film surface inhomogeneity. The analysis employs a successive approximation technique applicable only in cases where the incident and reflected waves propagate at angles substantially different from the cut-off angle.

### Theoretical Investigation of Surface and Near-Surface Acoustical Waves in Layered Structures by the Green's Function Technique

18620148a *Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 257-263

[Article by D. I. Mezhuiev]

[Abstract] This study develops the Green's function technique for a homogeneous acoustic channel for the case of a layered structure and obtains the Green's function of a linear electrical source in the layered structure that provides a complete characterization of the phase and energy characteristics of all types of acoustical waves excited by this source. The Green's function of the linear electrical source is calculated using an ALGOL program on the BESM-6 computer. The calculation technique

developed in this study is used to determine the properties of all acoustic waves excited by electrical sources in various layered structures. Extrinsic surface waves that can distort both the amplitude-frequency responses of surface-acoustical wave devices and can be used as an information medium in acoustoelectronic devices with enhanced properties are detected in a zinc oxide/sapphire structure. The study concludes that applying a surface layer of specific thickness onto a homogeneous acoustic line enhances the properties of surface volumetric acoustic waves of both polarizations and the performance of acoustoelectronic devices based on such waves.

### Field Diffraction with the Caustic at a Wedge in an Inhomogeneous Medium

18620148b Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 264-273

[Article by V. A. Borovikov]

[Abstract] This article formulates the asymptotics of a solution to the problem of radiant field diffraction with the simple caustic located at a wedge in an inhomogeneous medium. The formulae derived in this study describe the principal term of the shortwave asymptotics of the wedge-scattered field with any relative position of the wedge edge and the incident field caustic and with any relative position of the point of observation and the shadow boundaries: the incident field light. The analysis assumes that the rays of the edge wave excited at the edge together with the primary and reflected fields do not form caustics near the observation point. The analysis derives equations for a number of particular cases including: a) the edge P is far from the caustic, i.e., the field incident on P is the sum of two radiant fields, while the observation point is far from the shadow/light boundaries for the incident or reflected fields; b) the edge P is far from the caustic while the observation point m is near one of the shadow/light boundaries; c) edge P is near the caustic while the observation point m is far from the shadow/light boundary; and finally the edge P is near the caustic and the observation point m is near one of the shadow/light boundaries. The asymptotics are expressed through an Airy-Fresnel integral.

### The Field Formation Range and Fresnel Volumes

18620148c Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 273-282

[Article by V. A. Borovikov]

[Abstract] This article introduces the concept of the "field formation range at the point of observation M." This range is defined as the vicinity of a ray passing through point M where the absence of local perturbations to the medium within the range guarantees applicability of geometric optics for calculating the field at point M. Essentially this field represents a combination

of all the first Fresnel zones on the ray. The study determines the field formation range for an inhomogeneous medium and a field containing a caustic when the ray encounters the simple caustic before reaching the observation point. The article also discusses other analyses of these problems and other names applied to the range under analysis including the "range significant for radio wave propagation", the "spatial Fresnel zone", the "three-dimensional Fresnel zone", etc. A critique of these analyses is provided.

### Direction Pattern Analysis for a Phased Array Consisting of Large-Aperture Modules

18600159f *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 53-55

[Article by G. A. Polukhin]

[Abstract] This article obtains an analytic estimate of energy losses in the interference lobes for a phased array consisting of large-aperture modules with aperture dimensions of tens, hundreds, or more wavelengths. The analysis focuses on a multimodule array of identical rectangular modules with aperture dimensions of  $l_x$  by  $l_y$  in an array with a rectangular cell  $d_x$  by  $d_y$ . A direct relation is found between the directional pattern parameters of a multiple-module phased array and the dimensions of the gap between the modules. The directional pattern of such an array has multiple interference lobes whose angular orientation corresponds to the array geometry. It is also determined that the strongest interference lobes closest to the main lobe have a constant level corresponding to the spacing factor between the modules. The formulae derived in this study therefore make it possible to estimate interference lobe energy losses as well as the levels of the strongest interference lobes for a phased array of large-aperture modules of dimensions exceeding 20 wavelengths.

### High-Latitude Disturbances in Software Radiowave Propagation Channels

18600159g *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 59-62

[Article by D. V. Blagoveshchenskiy]

[Abstract] This article analyzes a variety of diagnostic and forecasting methods for predicting magnetic-ionospheric disturbances and radiowave propagation conditions of important practical significance for radio communications, radio broadcasting, detection and ranging, navigation, direction finding, etc. The ionospheric disturbances considered in the analysis include sudden ionospheric disturbances (SID), polar cap absorption (PCA), auroral absorption (AA), and ionospheric F-layer disturbances. The diagnostic system under consideration requires real-time transmission of information to a data processing center. The diagnostic routine utilizes a set of signals along the system routes for which the statistical data sets representing parts of the signal model are calculated by computer in real time.

The signal characteristics include: the parameter of the Nakagami law, the temporal correlation radius, the signal mean, the probability of anomalous amplitude distribution laws, and the nonstationarity parameters. The article also considers an original method of sub-storm forecasting based on diagnostics of software radio noise of atmospheric origin. The characteristic regularities of the atmospheric disturbances are analyzed. The study develops a new technique for real-time forecasting of magnetic-ionospheric disturbances using a software radio route system. Real-time diagnostics of sudden ionospheric disturbances as well as sudden initiation of magnetic storms can be based on data recovered from processing of the dynamic spectra of software signals obtained by high-resolution Doppler techniques. The proposed system of routes can be used to monitor the onset of disturbances over a broad range based on observations at a single site. Real-time diagnostics of the atmospheric disturbances discussed in this article can provide a forecasting accuracy with a probability of approximately 60 percent for sudden ionospheric disturbances and approximately 95 percent for magnetic storms.

#### Efficiency of Sequential Detection of Continuous Gravitational Radiation

18600159h *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 62-65

[Article by A. P. Trifonov, S. V. Vetrov]

[Abstract] This article analyzes serial detection algorithms employed to detect continuous gravitational radiation. The study derives several expressions that are used to find the average advantage in observation duration obtained by using the serial routine. The formulae can then be used for calculating the characteristics of serial detection of a harmonic signal with an unknown initial phase against a background of Gaussian white noise with a one-sided spectral density.

#### Application of Tomography to Microwave Engineering

18600160a *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian*  
Vol 32 No 2, Feb 89 pp 4-18

[Article by D. I. Voskresenskiy, Ye. N. Voronin, R. P. Kaminskiy]

[Abstract] This article is a survey of classical and computer tomography techniques and equipment for application to imaging and sonography. The article covers such areas as tomographic sonography techniques, geometric optics approaches, wave methods, the contrast material technique, and analyzes tomographic reconstruction algorithms as well as tomographic imaging and sonography techniques and equipment. Certain specific features of tomographic processing in the time domain are discussed together with tomographic synthesis in the frequency domain and other applications. The article

points out that the sphere of application of tomographic techniques is quite broad and encompasses both traditional methods of imaging and sonography as well as other applications to important problems of sample recognition based on indirect data from microwave imaging. Other possible applications include broadband airborne imaging, monochromatic and monostatic detection and ranging of rapidly rotating objects and similar modifications.

#### Fiber-Optic Signal Distribution and Processing Systems for Arrays

18600160b *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian*  
Vol 32 No 2, Feb 89 pp 19-31

[Article by A. N. Bratchikov, A. Yu. Grinev]

[Abstract] This article is a survey of the current state and prospects for the development and application of fiber-optic and integrated optic systems to radar signal processing and distribution functions traditionally performed by standard microwave systems. The survey includes such areas as fiber-optic signal isolation systems in antenna arrays, fiber-optic amplitude-phase calibration systems, fiber-optic multibeam beamforming in phased arrays, fiber-optic spectral-time processing systems, and certain signal distribution and processing systems for antenna arrays. The examples cited in this article confirm the validity and promise of fiber-optic signal processors and distributors for antenna arrays. The article points out that the effectiveness and competition presented by the new generation of equipment must be determined for each specific application based on evaluations and comparisons of the most important parameters such as bandwidth, dynamic range, sensitivity, energy efficiency, phase stability, etc.

#### Microstrip Antenna Arrays with Traveling Wave Radiators

18600160c *IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: RADIOELEKTRONIKA in Russian*  
Vol 32 No 2, Feb 89 pp 43-47

[Article by V. S. Filippov, S. A. Pavlov, A. A. Sapozhnikov]

[Abstract] This study reports results from an investigation of microstrip antenna arrays with traveling wave radiators. A multilayered dielectric coating is applied to provide protection from external influences and to improve electrical properties. The exciters are represented as voltage oscillators connected at the radiator inputs between the screen and the plane conductor. Direct numerical techniques are used to determine the properties of the traveling wave radiators and the resulting antenna arrays. This problem is reduced to the familiar problem of exciting a regular radiating structure due to the significant range of calculations required for direct solution of the functional equations for the current flowing through plane conductors at radiator lengths



exceeding the wavelength. This approach is also applicable for determining the characteristics of isolated traveling wave radiators. The parameters of the regular structure in this case are selected on the basis of convenience and minimum calculation time. The method was also used for developing algorithms and programs for modeling arrays of this type.

#### **Selection of the Design Parameters of Folding Umbrella-Type Reflector Antennas**

18600160d IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 32 No 2, Feb 89 pp 58-61

[Article by E. Yu. Burmenko, M. V. Gryanik, V. I. Loman, V. N. Pilishenko, V. N. Samilov, V. V. Tarasenko]

[Abstract] This article focuses on the procedure for selecting the design parameters of a folding umbrella-type reflector antenna. The proposed procedure includes selecting the antenna structural design as well as the number of antenna ribs and the reflector depth, together with the subreflector diameter and the control range for adjusting the radiating system. The proposed method was used to select the structural parameters for two umbrella-type antennas. This design procedure made it possible to reduce the axial dimensions of the antenna by a factor of 1.5 in its unfolded position yet reduced structural rigidity and caused a certain loss of gain. The study provides test results for both antennas and suggests that the proposed technique for selecting the design parameters of a folding umbrella-type reflector antenna makes it possible to achieve acceptable electrical performance characteristics with a minimum possible number of antenna ribs and, therefore, reflector weight as well as to simplify the tuning of the umbrella-type antenna.

#### **Properties of Flat Reradiant Dipole Structures**

18600160f IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 32 No 2, Feb 89 pp 76-78

[Article by L. I. Ponomarev, A. V. Shatalov]

[Abstract] This brief report discusses an algorithm developed for analyzing and optimizing the performance of plane reradiant dipole structures. The primary characteristic of a reradiating structure is the transmission factor of the incident waves and its dependence on the direction of incidence and the frequency. In order to calculate this characteristic this study solves the problem of plane electromagnetic wave incidence on a periodic array. The response of the lower array is accounted for within the scope of an electrodynamic model by means of concentrated loads connected to the dipole of the upper array. An algorithm based on integral equations is then used to calculate the wave impedance of the dipole radiators making up an infinite periodic array. The current distributions along the dipoles of one periodic array are obtained and plots of the array period versus

the transmission factor are provided. An analysis of the relations indicates that optimum performance is achieved by using a structure with a flat sheet of reradiant elements. The algorithm developed here can be used to efficiently analyze the performance of dipole reradiant structures over a broad frequency band and a wide range of angles and to identify the primary areas where antenna structural parameters have an effect on antenna performance.

#### **The Characteristics of "High-Q" Microstrip Radiators in a Plane Phase Antenna Array**

18600160h IZVESTIYA VYSSHIKH UCHEBNIKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian  
Vol 32 No 2, Feb 89 pp 81-82

[Article by V. S. Filippov, K. I. Semenov]

[Abstract] This study analyzes the results from a numerical solution to electrodynamic modeling of single-channel high-Q microstrip radiators excited by a coaxial feed line in a plane infinite phased array. Consistent with Floquet's theorem a single period of the antenna structure is analyzed in place of an infinite array of radiators excited by a system of waves of equal amplitude and linearly-varying phase. The solution to the boundary problem for an infinite plane phased antenna array of square microstrip radiators on a multilayered substrate with a multilayered dielectric coating is implemented as an applied program package which was employed to run the numerical experiment. The analysis focuses on one interesting feature of "high-Q" radiators in such an array which is that the frequency properties of such radiators may be substantially improved by selection of the geometric and electrical parameters of the coating. The analysis reveals that microstrip "high-Q" radiators can be successfully employed to expand the operating frequency band not only by increasing the height of the board over the screen, which is not always convenient, but also by using material with a high relative permittivity as the coating and by increasing the coating thickness while maintaining the original height of the radiator plate.

UDC 621.391.01:621.396

#### **Interrelation Between Probability Distribution and Intensity of Spikes in Natural Radio Noise**

18600188c Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 34 No 3, Mar 89 pp  
636-640

[Article by V. V. Kabanov]

[Abstract] Detection of discrete signals by a locally-optimum receiver with a nonlinear element in the presence of VLF and SLF natural radio noise is considered, and algorithm having been constructed which utilizes the relation between the probability distribution of the intensity of noise spikes and the sensitivity of the recording apparatus. The noise probability density is



calculated from the dependence of the intensity of noise spikes on the intensity of the incident electromagnetic field, natural radio noise being represented as a random non-Gaussian process with a dispersion which varies in time. The algorithm and its underlying premise are validated by the results of an experimental study made in the region from Irkutsk to Magadan over the summer-autumn 1984 period, 140 tests of 100 s duration with 0.4-9.5 kHz signals in VLF noise and 50 tests of 500 s duration with 5-1000 Hz signals in SLF noise. The author thanks L. T. Remizov for constructive critique. Figures 1; references 9; Russian (1 CCIR).

### RF Pulse Propagation Within the Oxygen Absorption Band

18600194c *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 16-17

[Article by G. M. Strelkov, I. V. Soldatova]

[Abstract] This article examines the case where the frequency of an AM RF pulse is close to the central frequency of the oxygen absorption band (approximately 60 GHz). Computer calculations of signal envelope distortions were run on the YeS-1045 computer. The article discusses the distortions induced in a square-wave pulse for various pulse durations, frequencies, and propagation path lengths. Overall the numerical modeling results suggest that the oxygen absorption band has a substantial influence on the envelope of nanosecond pulses propagating along atmospheric channels at reduced atmospheric pressures.

### Real-Time Calculation of HF Wave Properties in a Longitudinally-Gradient Ionosphere

18600194g *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 56-60

[Article by A. I. Smirnov]

[Abstract] This article develops and carries out extensive testing of a real-time calculation method suitable for computing HF wave properties in a multilayered ionosphere with properties that vary along the propagation path. Approximate and exact formulae are derived for calculating the range at a ratio of the operating frequency to the critical frequency of two and specific ionospheric geometric parameters characteristic of the  $F_2$  layer. Analysis reveals that the approximate formulae can be used to calculate the lower, upper, and transmission beams. The average calculation time for a single beam trajectory on the YeS-1033 computer using the approximate formula is 0.23 sec; the average calculation time is 6 sec using exact (in the ray approximation) formula provided in the article for a local calculation accuracy of 10 m by means of fourth order Runge-Kutta integration with automatic step selection and prediction. The approximate formulae derived in this article can be used for real-time calculations of the above-mentioned beams in a multilayered ionosphere with longitudinal gradients.

### Self-Consistent Absorption of Electromagnetic Waves by a Ferromagnetodielectric Layer

18600194h *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 60-62

[Article by D. I. Mirovitskiy, V. M. Petrov]

[Abstract] This article carries out a theoretical analysis of the reflection of a plane electromagnetic wave incident normally on a plane ferromagnetodielectric layer. The analysis focuses on three conditions that provide good matching of the ferromagnetodielectric layer on a flat metallic screen and free space. The first condition holds for a very thin layer where both waves reflected off both interfaces (the air-layer entrance interface and the layer exit-metal interface) are equal and in antiphase due to proper selection of the corresponding electromagnetic parameters of the layer. In the second condition the layer thickness is equal to a quarter wavelength in the material, causing the waves to be in antiphase. In the third condition there is no reflection off the entrance interface, but rather the wave entering the layer and reflected off the metal is damped entirely from double passage through the layer and makes no exit. On this basis the article derives specific requirements on the magnetic and dielectric susceptibilities (accounting for the nature of their frequency dispersions) as well as on the thickness of the screened layer based on the conditions formulated for the three types of low-reflection ferromagnetodielectric integrated circuit layers. The self-consistent frequency band of the layer is determined by the range of the magnetic and dielectric dispersions.

### Fluctuations in the Main Lobe Direction of the Directional Pattern of a Transmitting Antenna on Integrated Terrestrial Routes

18600194i *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 62-63

[Article by P. N. Dagurov, A. S. Zayakhnov, A. Ye. Tsybikov, N. B. Chimitdorzhiev]

[Abstract] This study carries out an experimental analysis of the fluctuation dispersion of radiowave angles from diffraction and scattering of SHF waves by the peaks of obstacles along the transmission routes. Analysis of the space-time distortions to the transmitting antenna directional pattern in this study revealed significant deformations to the main lobe. The space-time deformations of the directional pattern on routes containing obstacles are found to produce substantial fluctuations in the direction of the main maximum of the directional pattern with respect to the geometric line interconnecting the communications stations. The fluctuation dispersion is found to be substantially lower at the maximum of the spatial field distribution than at the minimum, although fluctuations in the wave angles on the route may exceed 6 to 7° regardless of the point of observation on a spatially-inhomogeneous field pattern.

This analysis suggests the need to account for fluctuations in wave angles when the propagation route contains natural obstacles when designing antennas,

establishing communications links, and providing electromagnetic compatibility of radio equipment in municipal areas.

**Design Features of a Phase-Locked Loop with a Logic Pulsed-Phase Detector***18620127c RADiOTEKHNIKA in Russian  
No 1, Jan 89 pp 18-20*

[Article by Ye. Ye. Getmanova, A. N. Yermak, N. V. Lyapunov]

[Abstract] This article carries out a general design analysis of a phase-locked loop system employing a logic pulsed-phase detector. The article demonstrates that the lock-on condition of the synchronized oscillator is strict correlation of the sign of the frequency change of the tunable oscillator to the slope of the phase detector characteristic. The pulsed-phase detector analyzed in this study was fabricated from a 561 CMOS integrated circuit. The d.c. amplifier-integrator has a variable output voltage from .05-10 V. The phase locked loop operating range is 1.02 MHz is less than  $f$  is less than 0.96 MHz and is limited to the operating speed of the 561 integrated circuit.

**Microelectronic Sensors: The Current Status of the Problem in the USSR and Future Prospects***18620132a Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 1, Jan 89 pp 14-15*

[Article by Yu. I. Blokhin, A. O. Olesk]

[Abstract] This article is a survey of the current status of microelectronic sensor manufacturing around the world. A general review of the primary microelectronic sensor designs, operating principles, and applications is given. The increasing demand for microelectronic sensors on the international market and the rates of growth in the United States and Western Europe are discussed. The article lists the principal foreign manufacturers of microelectronic sensors and the primary markets served by these manufacturers. With regard to the Soviet market the article argues that a special subdivision of instrument manufacturing—sensor manufacturing—should be established in view of the special features inherent in modern microelectronic sensors. This argument is based on the fact that many microelectronic sensors manufactured by separate enterprises in the Soviet Union do not meet modern speed, sensitivity, reliability, stability, weight, size requirements. The article identifies several steps for future improvements in the manufacture of microelectronic sensors including the scientific search for new design principles for various electronic sensors, the fabrication and investigation of new sensor materials, the development of waste-free manufacturing technology, the development of sensor design techniques that maximize the integration of all components using computer-aided design; the development of modern circuit designs for electronic circuitry used in sensors and the establishment of economical design and fabrication techniques that will make sensors mutually advantageous to designers and customers.

**High-Temperature Superconductors and the Prospects for Their Application in Sensor Manufacturing***18620132b Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 1, Jan 89 pp 15-17*

[Article by A. O. Olesk, B. A. Talerchik, T. N. Yegorova, Yu. V. Bobkov]

[Abstract] This article is devoted to a review of research on select high-temperature superconductor compounds and the prospects for their practical application in sensor manufacturing. Certain properties of ceramic superconductors are discussed together with possible electronic applications. The ceramic superconducting materials included  $\text{YBa}_2\text{Cu}_3\text{O}_{9.8}$ ,  $\text{LaBa}_2\text{Cu}_3\text{O}_{9.8}$ ,  $\text{EuBa}_2\text{Cu}_3\text{O}_{9.8}$ , as well as certain related compounds. The temperature dependences of the resistivity of certain specimens fabricated from these materials are given. It is noted that the properties of the materials are highly dependent on their oxygen concentration. The value of  $\delta$  also determines the order-disorder transition, influences the crystalline lattice structure of the compound and its parameters. The article discusses several promising applications of high-temperature superconductors in electronic sensors such as superconducting thermal radiation sensors: superconducting bolometers (including multielement and integrated bolometers), and superconducting integrated Abrikosov sensors. Another possible application includes superconducting quantum interference devices: SQUIDS. Other interesting possible applications including superconducting integrated circuits and the application of high-temperature superconductors for intercomponent connections in semiconductor integrated circuits.

**Noncontact Heating System Based on Spectral Frequency Separation***18620132f Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 1, Jan 89 pp 21-22*

[Article by S. V. Degtyar, V. V., Baranov, A. A. Karmanov]

[Abstract] This article examines selected temperature control and stabilization techniques used in the vacuum electronics industry. Several different temperature monitoring and control techniques are discussed. This article introduces a heating method that employs a heater (a mercury lamp) and a sensor (a TSP resistive temperature transducer) in a ceramic housing. The sensor and the substrate are mounted on the same level and at an identical distance from the heater. The advantage of this design is that a given substrate temperature can be attained many times although the method makes it difficult to estimate the actual substrate temperature as the substrate temperature will drift from cycle to cycle due to dust accumulation on the sensor. The article also discusses a mercury lamp/pyrometer transducer design and an ultraviolet lamp/pyrometer transducer design.

routine is then run on a YeS-1060 computer to determine the detection characteristics of the derived decision rule optimized for the case of known interference parameters. The calculation results indicate that the decision rules are sufficiently effective.

### Application of a Set of Invariants to Bearing Identification in Direction-Finding Systems

18620136g Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 1, Jan 89 pp 96-105

[Article by Yu. G. Bulychev, A. A. Korotun]

[Abstract] This article employs a set of invariants to solve a general problem of bearing identification in a kinematic formulation for direction-finding systems with both fixed and mobile receiving stations. This method makes it possible to improve the reliability of the solution compared to traditional approaches and reduces the volume of calculations by separate information processing which is important for multiple target detection and ranging systems with limited available time. In addition to the formulae the article provides a block diagram of the device used to implement the proposed method. The device, which includes multiple integrators and a decision unit, produces both the true bearing crossing point and the false bearing crossing point. The formulae derived in this study for calculating the probability characteristics of the detection and ranging algorithm can be used to establish precision requirements on direction-finding systems and the necessary number of invariants for achieving a high degree of reliability of the solution.

### Electrodynamic Model of Microwave Hyperthermia

18620136h Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 1, Jan 89 pp 187-191

[Article by A. D. Khzmalyan, A. F. Chaplin]

[Abstract] This article proposes one possible approach to formulating an electrodynamic model allowing calculation of the primary characteristics of microwave hyperthermia equipment. The model is based on a numerical solution of an integral equation derived for the polarization current in the human body. The equation is solved by the Halerkin method. The study also derives equation systems for determining the most interesting properties relevant to the analysis such as the field scattered by the body as a sum of the fields radiated by the polarization points and the density of radiated power delivered to the body. This model employs a breakdown of the body into parallelepiped cells located at the nodes of a three-dimensional rectangular grid. The study carries out a sample calculation for the case of the excitation of an elliptical cylinder in free space consisting of a homogeneous dielectric bounded by elliptical curves; this cylinder is excited by eight synchronous electrical current

filaments of equal amplitude. This problem is used to model a cross-section of human breast cells exposed to hyperthermia. A computer calculation of the power density distribution based on the derived equation systems revealed an accuracy of  $10^{-2}$  (RMS norm) and  $10^{-3.6}$  (Chebyshev norm) over 57 iterations. This electrodynamic model yielding the computer algorithm implemented as an applied program package can therefore be used to predict the properties of microwave hyperthermia equipment.

### Estimation of the Signal-to-Noise Ratio at the Output of Time-Integrating Acoustooptic Correlometers

18620148e Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 339-347

[Article by V. B. Polyakov, V. V. Safonov]

[Abstract] This article estimates the output signal-to-noise ratio from time-integrating acoustooptic correlometers of various designs in the general case including the case of zero a priori information on the received signal. The analysis is carried out for two primary types of correlometers: a square-law correlometer and a direct multiplication correlometer. The analysis indicates that at high signal-to-noise ratios the square-law correlometer provides somewhat higher advantage in terms of the output signal-to-noise ratio than does the multiplication correlometer. The analysis provides a table which shows that the direct multiplication correlometer is preferred from the viewpoint of output signal-to-noise ratios with low input signal-to-noise ratios. The primary advantages of the time-integrating acoustooptic correlometers analyzed in the present study include the capability to calculate correlation functions simultaneously for several thousand delay values between the input signals together with the high accumulation time-signal band product. The output signal-to-noise ratio of these correlometers is comparable to that of a matched filter based on an ideal correlator.

### Investigation of the Correlation Properties of M-Like Sequences and Ensembles

18620148f Moscow *RADIOTEKHNIKA I ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 348-352

[Article by V. P. Ipatov, B. Zh. Kamaletdinov, I. M. Samovolov]

[Abstract] This article examines the claim of a discovery of a class of nonlinear binary sequences (M-like sequences) of length  $l$  with a periodic autocorrelation function equal to  $-1$  with shifts of any number of positions not equal to  $l$  made by Quynh and Prasad. The analysis carried out in this study suggests that in fact the M-like sequences are Gordon-Mills-Welch sequences first described by the aforementioned authors in 1962 and later discussed by Scholtz and Welch in 1984. The

employing an infrared filter. The design and operation of these units are briefly discussed

### **Fiber-Optic Temperature Sensors Based on Impregnated Polymers**

18620132g Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 1, Jan 89 pp 22-23

[Article by F. M. Aliev, R. Sh. Tukhvatulin, M. M. Butusov, I. K. Meshkovskiy, A. B. Zarubin, I. M. Samoukova, N. L. Urvantseva]

[Abstract] This article presents results from the development and investigation of two types of fiber-optic temperature sensors. These sensors are based on the change in light transmittance of their sensors as a function of temperature. In these fiber-optic sensor designs the sensors are mounted in a gap between the ends of silica glass-polymer optical fibers with core and cladding diameters of 400 and 900  $\mu\text{m}$ , respectively. In both cases the sensors were fabricated from impregnated organic silicon polymers. These specimens were used in tests to determine the dependence of the output signal on temperature for fiber-optic sensors with the sensor elements based on a polymer-liquid crystal mixture and for the case where the sensor elements are based on a porous silicate glass composite including an SiEL compound. The analysis revealed that the signal grew by a factor of 150 with increasing temperature from 80 to 95°C. The temperature dependence of the output signal was found to manifest a hysteresis nature for all sensor designs

### **New Properties of the Tandem Connection of Coupled Transmission Line Sections**

18620136b Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian  
Vol 34 No 1, Jan 89 pp 28-34

[Article by V. P. Meshchanov, I. A. Tsots]

[Abstract] This study is devoted to an investigation of the properties of a tandem connection of  $n$   $\pi$ -wave coupled line sections of various lengths and identical coupling coefficients; this analysis accounted for the lengths of the connection sections of identical transmission lines and a solution to the directional coupler design problem based on such a connection. The analysis was carried out for three different structural design variants. In variant 1 it was assumed that a phase shifter was installed in place of the line section; this phase shifter provides a 90° phase shift across the entire operational frequency range. In variant 2 a 180° phase shifter is used in place of the line section and in variant 3 a 90° phase shifter is used in place of the connection section of different normalized lengths. Tables are given to illustrate the optimum parameters of the tandem connection of two coupled line sections in various design configurations. An analysis of the results suggests that accounting for the lengths of the connections sections in designing a directional coupler based on a tandem connection of

coupled transmission line sections with identical coupling coefficients makes it possible to substantially expand the operating frequency range. Specifically variant 3 had the optimum amplitude-frequency response since it has the lowest transient attenuation drop. The article also makes mention of the fact that structures in which a fixed phase shifter is used as one of the connections sections is a special case as such structures can be used to fabricate ultrabroadband directional couplers with a rather low attenuation differential

### **Alternating Adaptive Tuning Rate in Jamming and Clutter Protection Systems**

18620136d Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian  
Vol 34 No 1, Jan 89 pp 52-58

[Article by Yu. I. Abramovich, V. G. Kachur]

[Abstract] This article analyzes a variety of adaptive alternating tuning routines for application to combined jamming and clutter protection systems. The article considers a rather typical situation where the protected channel (beam) contains, in addition to a clutter signal, jamming signals on the side lobes of the directional pattern; the analysis ignores clutter in the compensated spatial channels. The mathematical analysis derives estimates of the convergence and rates of convergence of the successive adaptive tuning routine of separate spatial and temporal compensation systems for jamming and clutter protection systems. The analysis identifies optimum parameters of such routines that are determined by the jamming and clutter properties thereby making it impossible to further improve operational algorithms by adaptive determination of these parameters during the tuning process

### **Maximum Likelihood Detection of a Quasideterminate Signal Against a Background of Gaussian Autoregression Interference With Unknown Parameters**

18620136f Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian  
Vol 34 No 1, Jan 89 pp 89-96

[Article by S. I. Zakharov]

[Abstract] This article considers a generalization of the problem of harmonic signal detection against a background of stationary Gaussian autoregression interference with unknown parameters to the case of a quasideterminate signal of any arbitrary form. The decision rules derived in this case can be used for detection and differentiation of complex intrapulse-modulated signals against a background of interference with unknown parameters of the power spectrum. The derived decision rules are obtained by maximum likelihood techniques. The study proposes a routine for solving a system of nonlinear equations for maximum likelihood estimates of the unknown signal and interference parameters. This



article also concludes that in terms of correlation properties these sequences are inferior to both a small Casami set and a family of bent function sequences.

#### **Matched Signal Filtering in a Noncoherent Optical Correlometer**

18620148g Moscow *RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 353-360

[Article by N. F. Uslugin]

[Abstract] This article analyzes the possibility for signal processing for circular antenna array signals in a noncoherent optical correlometer. A morie matched filter is obtained by superimposing two phase-modulated arrays and this structure is easily tunable. The analysis derives relations for the dimensions of the coherence zone of such a filter and designs an experimental setup to test for matched signal filtering in the noncoherent optical correlometer. The estimates and experimental results from this study suggest that a tunable optical filter can be used to implement matched signal filtering of circular antenna array signals in a nonshifting, noncoherent optical correlometer.

#### **Optoelectronic RF Pulse Shaper for Variable Waveform Pulses Electrostatic System**

18620148j Moscow *RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 438-441

[Article by V. A. Dianova, V. B. Baglikov, F. R. Mustel, V. N. Parygin, A. Yu. Agamalova]

[Abstract] This study investigates the possibility of fabricating an RF pulse shaper for FM pulses using a waveguide interferometric light modulator whose principle of operation is based on the linear electrooptic effect. This optoelectronic pulse shaper design includes a laser source, an interferometric modulator with two inputs (a primary input and a set input), an optical fiber and a photodetector. In this design the optical radiation from the laser source is sent to the interferometric modulator. A control voltage is injected to the primary input while a fixed voltage is input to the set input; this is used to select the operating point on the modulation characteristic. The modulated radiation is then transmitted on the optical fiber and is detected by the photodetector. The experimental investigation of this unit was carried out using a Mach-Zehnder interferometer with an internal laser diode operating at  $\lambda$  equals 0.83  $\mu\text{m}$ . The modulator transmission band at 3 dB was 300 MHz. A FAU-60 photomultiplier was used as the photodetector. This study measured the dependence of the RF carrier frequency on the amplitude of a sawtooth voltage for the case where a sawtooth voltage of approximately 1 ms in duration is injected to the primary input. The relation was, as anticipated, a linear relation. The experiment was conducted at relatively low

frequencies. However, such a pulse shaper can be implemented up to frequencies determined by the bandwidth of the modulator and the limit frequency of the photodetector.

#### **Radiowave Reflection Off an Arbitrary Ionospheric Layer**

18620148k Moscow *RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 233-240

[Article by V. Ye. Kunitsyn, V. A. Smorodinov, A. B. Ushaev]

[Abstract] This article is devoted to a method of solving the problem of radiowave reflection off of arbitrary ionospheric layers and algorithms based on this method. The radiowave reflection problem is solved within the framework of the widely-accepted approximation of an isotropic ionosphere and scalar waves when the radiowave field  $E$  satisfies an Helmholtz equation. The techniques developed for solving the problem of radiowave reflection by the ionosphere for both the case of partial reflection and total reflection and mutually-suppressing techniques with different, adjacent areas of application. These methods are then used to develop numerical algorithms and many calculations including test calculations are carried out to confirm the accuracy and effectiveness of the techniques.

#### **Zero Phase Loss FSK Signal Differentiation Algorithm**

18600159a *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 3-6

[Article by D. A. Kopylov, S. I. Lopatin]

[Abstract] This study synthesizes a quasioptimum algorithm for signal differentiation based on the maximum likelihood of a sequence of zero phase loss frequency-shift keyed signals. Relations are derived in the study that make it possible to synthesize an adaptive detection algorithm for discrete zero phase loss frequency-shift keyed signals. The algorithm performs such operations as calculation of the vector of the complex signal envelope samples, determination of the most likely transition to each state in accordance with specific relations as well as decision making, evaluation of the most likely pair of signal states and correction of the present estimate of a coexistent parameter. The number of calculations required by these expressions is proportional to the number of phase states. The applicability of the differentiation algorithm proposed here is therefore limited to the range of efficient values of  $\beta$ . Zero phase loss FM signals with  $\beta$  equal to  $\pi$  are used for transmitting discrete messages on telephone channels in accordance with CCITT Recommendations V.21 and V.23. The proposed algorithm has demonstrated the possibility for detection of discrete FSK signals by successive analysis of carrier phase values in the same manner employed to detect discrete differential phase shift keyed signals.

**Measurement of Two-Port Scattering Parameters in Large Signal Conditions***18600159c RADIOTEKHNIKA in Russian  
No 2, Feb 89 pp 18-20*

[Article by A. V. Khramov, G. V. Petrov]

[Abstract] This article develops a method of measuring two-port scattering parameters in large signal conditions using standard equipment. The method was implemented for measuring the S-parameters of the KT647A transistor in large signal conditions at 3 GHz. An FK2-18 phase difference meter and R1-22 test lines were used in the experimental setup. No significant changes in the scattering modulus with increasing input power were recorded in the course of the experiment. The measurements also confirmed that the modulus of the scattering parameter is the only element dependent on the input power in oscillator transistors of the type under analysis. Employing two phase different meters in the assembly made it possible to substantially increase efficiency by reducing the measurement time since two S-parameters are measured in this case. The proposed method has a rather high degree of efficiency and does not require unique nor expensive equipment.

**Matched Low Loss SAW Filter for PSK Signals***18600159d RADIOTEKHNIKA in Russian  
No 2, Feb 89 pp 24-25*

[Article by A. S. Kozlov, A. A. Kreymer, N. I. Tolstoukhov]

[Abstract] This article analyzes a method of reducing losses in a matched low loss surface acoustical wave filter. This filter consists of two interdigital converters on a piezoelectric acoustic line. Two PSK signal matched filters with an ST, X-cut quartz acoustic line were fabricated together with zinc oxide films of various thickness on an ordinary interdigital converter. The zinc oxide was applied by means of magnetron deposition. The central frequency of the matched filter was 100 MHz with the transmission band at 4 dB equal to 20 MHz with 256 pins and convolution losses without the ZNO film of -38 dB. At 100 MHz the velocity of the surface acoustical waves was 2800 m/s. The experiments carried out in the study revealed that the matched PSK signal filters have identical temperature stability with and without the zinc oxide films. The study concludes that reducing the induced losses in the filter by applying a strong piezoelectric on an ordinary interdigital converter will not serve to narrow the operating temperature range of the filter.

**Base Two and Four Fast Hartley Transform Algorithms***18600159e RADIOTEKHNIKA in Russian  
No 2, Feb 89 pp 31-36*

[Article by M. N. Yatsimirskiy]

[Abstract] This study carries out a comparative analysis of base 2 and 4 fast Fourier and Hartley transform algorithms; this analysis confirms the efficiency of fast Hartley transform algorithms for calculating discrete Fourier transforms of real sequences. The study describes base 4 time-decimated fast Hartley transform algorithms and base two frequency-decimated fast Hartley transform algorithms that permit substitutions. Various programs for implementing the algorithms are proposed and analyzed. The FTX4 program implements the base 4 fast Hartley transform algorithm and is used to perform a discrete Fourier transform of a real sequence. The FTX2 program implements the base 2 fast Hartley transform algorithm and is designed for performing a discrete Fourier transform of two real sequences. The FAST program implements a fast Fourier transform algorithm of a real sequence (base 4-2), while the FFT2 program implements a fast Fourier transform of a complex sequence (base 2). These programs, their efficiency and operating speeds are compared. The study demonstrates that the discrete Hartley transform and the fast Hartley transform algorithms represent a useful tool for calculating the discrete Fourier transforms of real sequences. The fast Hartley transform algorithms can be used to reduce calculation volume and the hardware configuration necessary for carrying out the transform.

**Computer Analysis of Electronic Circuits With Delay***18600159f RADIOTEKHNIKA in Russian  
No 2, Feb 89 pp 79*

[Article by V. A. Pospelov]

[Abstract] This article describes an algorithm for numerical solution of ordinary differential equations with a second or higher order delay argument. The step method is used. A combination of Taylor and Runge-Kutta formulae are used in each step to solve a Cauchy problem for ordinary differential equations without delay argument. The numerical solution of the ordinary differential equations with the delay argument is sought without transition to a normal system of ordinary differential equations. The sought function and its derivatives are calculated in each step as a truncated Taylor series. The solution program is written in BASIC for the "Elektronika D3-28" microcomputer. When the program is run a graph of the transient process and other necessary data are printed out. The numerical solution program can be used to calculate circuits containing delay elements such as feedback networks. The article provides a method of calculating active filters with decision amplifiers as well. A sample calculation of a second order low-pass active filter section with a transmission band far exceeding the cut-off frequency of the operational amplifiers is given.

**The Experience of Designing a Multistrip Radiator Based on Experimental Data**

18600159; *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 91-92

[Article by Yu. N. Novikov, F. A. Kopylov]

[Abstract] This article analyzes a two-channel radiator design emitting a circularly-polarized field. The radiating section is a microstrip line segment configured in a ring. The circumference of the ring is close to the wavelength of the fundamental mode propagating along the line. The analysis employs an experimental approach based on the Deshan technique to determine the elements of the scattering matrix of a reciprocal two-port based on measurements of the modulus and phase of the reflection coefficient at one input of the two-port and the

variable reactive load at the other input. This technique was then used to design a two-channel radiator producing a circularly-polarized field in the SHF range. The conducting networks were based on a balanced microstrip line. FAF-4 material was employed in fabricating the radiating ring; this material has a relative permittivity of 2.6. The study provides results from an experimental analysis of the radiation properties obtained when energy was applied to one of the inputs. The analyses revealed that the simple measurement data made it possible to substantially simplify the process of designing a radiator based on microstrip line. The radiator characteristics (broad directional pattern, circular radiation polarization over a broad range of angles) makes the device promising for applications in phased circularly-polarized arrays operating over a broad scanning range.

### Analysis of Electrical Trauma in the National Economy

18600189c *PROMYSHLENNAYA ENERGETIKA*  
in Russian No 3, Mar 89 pp 40-42

[Article by M. V. Bekker, A. S. Dalnov, N. Ya. Vyshinskaya, S. V. Tvaradze]

[Abstract] This article is a survey of electrical trauma accidents occurring in the Soviet national economy from 1952 through 1986. The article provides a breakdown of electrical trauma accidents by profession and industry within the national economy and discusses the dynamics of changes in such accidents in power equipment up to 1 kV and above 1 kV. Changes in the distribution of electrical trauma accidents by profession became evident in 1978. An increase in the number of accidents among electrical engineering specialists was identified and attributed to neglect of preventive measures. An increase in the number of electrical trauma accidents among construction personnel was also identified. Analysis revealed that approximately 13 percent of accidents were caused by a lack of information on the danger of electrical current available for nonspecialist personnel.

### Numerical Methods of Determining the Height of a Radiation Source in the Troposphere Accounting for Refraction

18620127g *RADIOTEKHNIKA* in Russian  
No 1, Jan 89 pp 63-64

[Article by Yu. L. Dmitrakov, N. A. Khudotyoplov]

[Abstract] This article derives algorithms for numerical solution of a ray equation in a layered-inhomogeneous spherical troposphere with a random refractive index. This algorithm can be used for carrying out field calculations by means of programmable pocket calculators. The algorithm eliminates the need to evaluate integrals thereby substantially reducing calculation time. The article also provides the dependences of the coefficients of refraction on the atmospheric parameters in both the RF and optical ranges, together with calculation results using the proposed algorithms.

### Generalized Algorithm for Sensitivity Analysis of Letov-Kalman-Optimized Tracking Systems

18620136e Moscow *RADIOTEKHNIKA* I  
*ELEKTRONIKA* in Russian  
Vol 34 No 1, Jan 89 pp 83-88

[Article by V. I. Merkulov, V. A. Efimov, O. N. Tomilin]

[Abstract] This article examines a method of obtaining a generalized algorithm for estimating the sensitivity of the Litov-Kalman functional; this technique makes it possible to account for variations in a tracked trajectory as well as existing perturbations without increasing the dimensions of the controlled position vector. The study derives equations that make it possible to estimate the

sensitivity of an optimum tracking system to variations in the model, tracking precision penalties, and control signal energy. The derived equations are used to draft an analysis algorithm. The algorithm employed to evaluate system sensitivity to the various factors outlined above differs from previous algorithms in that it includes an additional equation that more precisely accounts for variations of the tracking trajectory and external perturbations.

### The Minimum Number of Pulse Repetition Rates in a Pulsed Doppler Radar Probe Signal

18620148d Moscow *RADIOTEKHNIKA* I  
*ELEKTRONIKA* in Russian  
Vol 34 No 2, Feb 89 pp 334-338

[Article by V. A. Efimov, A. P. Sadovnikov, S. Yu. Terebulin]

[Abstract] This article employs combinatorial techniques to solve the problem of determining the minimum necessary number of sequences and selection of their pulse repetition rates for application to a pulsed Doppler radar probe signal. The given properties include the relative signal pulse duration, the maximum unambiguously measured delay and its measurement step understood to mean the maximum possible measurement error in zero noise conditions. A formula is derived in the course of the analysis and a graph of this formula clearly indicates that the diminishing relative pulse duration of the pulse sequence will serve to increase the minimum number of pulse repetition rates. The article also develops an algorithm that makes it possible to determine, with any given discreteness or unambiguous measurement range of the echo signal delay, the minimum necessary number of pulse repetition rates and their values with a fixed odd pulse repetition rate of the radar probe signal.

### Application of a Reference Source to Target Detection with an Unknown Probe Signal Type

18620148h Moscow *RADIOTEKHNIKA* I  
*ELEKTRONIKA* in Russian  
Vol 34 No 2, Feb 89 pp 376-384

[Article by Yu. V. Zhulilna]

[Abstract] This study examines the problem of detecting an object against a noise background when the echo RF signal is observed at M reception positions. The specific nature of the problem is that the object is eliminated by a signal from several transmission positions that are different from the reception positions. The probe signal is highly distorted due to the interference of the medium. This analysis therefore is a detection problem with an unknown probe signal. The article assumes a reference sources with known parameters in solving this problem. The unknown signal waveform and amplitude are estimated by the maximum likelihood method. All detection characteristics are calculated in an approximation of strong echo signals off the reference source compared to the noise background. The analysis suggests that the



potential position measurement accuracy and resolution of the synthetic multiposition system using the reference source are identical to analogous properties of an optimum noncoherent multipositional ranging system consisting of L transmit and M receive positions.

**Immunity to Additive Interference in  
Locally-Optimized Radioelectronic Tracking  
Systems**

18600159b *RADIOTEKHNIKA in Russian*  
No 2, Feb 89 pp 7-9

[Article by V. I. Merkulov]

[Abstract] This study analyzes the additive interference immunity in locally-optimized radioelectronic tracking systems and proposes a mathematical apparatus for its analysis. The analysis is based on a criterion of combined information and energy loss that makes it possible to obtain a quantitative integral estimate of the noise immunity of the system during its entire operation. In addition to tracking errors this estimate also accounts for the energy expended in control signals due to interference action. The study derives equations for the sensitivity factor of the locally-optimized radioelectronic tracking systems to additive interference. The study determines that in order to improve the noise immunity of such systems it is necessary to reduce the value of the coefficients of the derived penalty matrix on tracking accuracy. The study also includes a quadratic form of the sensitivity factor in the derived minimizing functional to synthesize the control algorithm for the locally-optimized radioelectronic tracking systems; this system

is optimum both with respect to providing high tracking accuracy with given constraints on control signal outlay and high noise immunity.

**Properties of a Synthetic Aperture Radar for  
Observing Fluctuating Objects**

18600160e *IZVESTIYA VYSSHIKH UCHEBNYKH  
ZAVEDENIY: RADIOELEKTRONIKA in Russian*  
Vol 32 No 2, Feb 89 pp 65-68

[Article by A. L. Ilin, A. Ya. Pasmurov]

[Abstract] This article examines an approach to optimizing synthetic aperture radar parameters in conditions of partial signal coherence for a signal reflected off a surface-distributed target. This approach is based on a mathematical analysis which suggests that it is possible to optimize synthetic aperture radar parameters for observing fluctuating objects by matching a spatial frequency filter to a narrowband space-time filter (the bandwidth of the latter is determined by the correlation time of surface fluctuations). This can be achieved by setting the synthesis time so that it does not exceed the signal correlation time. The contrast resolution of the radar will also be independent of the signal coherence time. The results obtained from this analysis suggest that it is advisable to use linear filtering theory and to represent the radar station as a filter with a certain frequency-contrast characteristic for describing the imaging process of fluctuating objects in a synthetic aperture radar; in this case the synthetic aperture radar is treated as a system that measures the space-time spectrum of the target object. Temporal signal fluctuations in the observation channel can also be assumed to be responsible for the multiplicative interference that degrades radar azimuthal resolution.

UDC 550.837

**Inspection of Agricultural Crops With Nanosecond Radio Pulses***18600188a Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 34 No 3, Mar 89 pp 550-556*

[Article by V. I. Karpukhin, A. N. Peshkov and M. I. Finkelshteyn]

[Abstract] Use of radio pulses for remote inspection of agricultural crops has been tried and developed since 1980, considering that these crops have essentially a multilayer structure. In the latest series of experiments inspection was done on ground, for the purpose of establishing the interrelation between electrophysical and biometrical characteristics of crops, and also from a helicopter at a not higher than 100 m altitude. The radar transmitter was a magnetron operating in the 3 cm wave band, generating pulses of 100 W power and 1 ns duration at a repetition rate of 10 GHz. For ground inspection were used two horn antennas mounted 2.5 m above ground and forming a beam 18 deg wide at half-power level. For aerial inspection were used a reflector antenna 764 mm in diameter and a ferrite circulator. The receiver consisted of a high-frequency amplifier for aerial inspection, a detector, and a video amplifier. The multichannel instrument for aerial inspection measured the amplitude of echo signals as well as the time interval between those arriving upon reflection by the crop-air interface and by the crop-soil interface respectively. The recording instruments were a multichannel N-338 voltmeter and an SI-75 oscillograph. Crops targeted for inspection were oat, barley, wheat, winter wheat, rye, sunflower, sorghum, alfalfa, and wood. They were inspected for height (cm), biomass (cwt/ha), and specific moisture content (cwt/ha.m). Ground and aerial inspection of 45 fields with those 12 different crops sown by the Latvian State Academy of agriculture has yielded data indicating a direct linear relation, with less than 0.1 variance, between the crop height and the time interval which separates the arrivals of the two echo signals as well as direct linear dependence of the signal attenuation (dB/m) on the crop biomass and on the specific moisture content, the correlation coefficient being 0.84 and 0.74 respectively. The authors thank Professor I. A. Kholms and Professor L. P. Yurshevskiy, also laboratory superintendent P. Ya. Bogomolov, for assistance in organizing the experimental study. Figures 4; tables 2; references 11: 9 Russian, 2 Western.

**Determination of the Azimuthal Arrival Angle of a Multipath Field in an Ionospheric Communications Channel***18600194a RADIOTEKHNIKA in Russian No 3, Mar 89 pp 3-6*

[Article by Yu. V. Berezin, I. P. Korotkov, V. V. Starchenko]

[Abstract] This article develops and tests a method of determining the azimuthal arrival angle of a multipath

signal reflected by the ionosphere at oblique incidence. Existing data from antenna theory and shortwave ionospheric radiowave propagation theory are used for this purpose. The study focuses on N spatially separated antenna elements integrated into a single spatial filter by a weighted adding system. The directional pattern of the spatial filter is generated by the vector of the weight coefficients. The analysis considers the features of direction finding of a multipath field produced from the frequency shift of the separate beams from their reflection by the ionosphere. The mathematical modeling results for this problem are provided for the particular case of receiving two plane waves of equal amplitude at arrival angles of 30°, 11° and 13° with different Doppler frequency shifts. Both mathematical analysis and physical experiments have demonstrated that a multielement spatial filter can be used to determine the azimuthal arrival angle of a multipath field propagating in an ionospheric channel; the directional pattern of this filter is formulated based on minimum received power in one vertical plane. The results suggest broad applicability of the spatial filters examined here for problems associated with determining the arrival angles of multipath fields reflected by the ionosphere at oblique incidence.

**Reference Fixing of a Television Image in Terrestrial Remote Sensing***18600194b RADIOTEKHNIKA in Russian No 3, Mar 89 pp 7-8*

[Article by I. S. Sorokevich]

[Abstract] This article examines a technique for reducing video information to a common coordinate system for applications to terrestrial remote sensing. This process of position-time fixing of sensing images consists of three stages. In stage 1 the external orientation elements of the television system are determined; these elements are given by the spacecraft vector and the orientation matrix of the coordinate system of the television camera with respect to the geocentric coordinate system. In stage 2 the calculated raw data are used to determine the position of the point of intersection of the optical axis of the television camera with the terrestrial surface. All calculations in step 2 of this process can be carried out directly onboard the spacecraft using the on-board computer and the coordinate grid line generator/calculator. In stage 3 the coordinate grid and the information determining the exposure time together with the geographic coordinates of the bearing point and the image scale are sent to a device that converts this information into a television signal. This reference fixing technique is implemented using the hardware onboard the spacecraft television system. A terrestrial remote sensing television system can be used to obtain and process large volumes of video information in real time. Reference fixing makes it possible to substantially reduce the preprocessing of video information and thereby improve its utility.

**The Magnetic Field and Parameters of an Asynchronous Motor Employing a Magnetic Fluid Medium**

18600184a ELEKTROTEKHNIKA in Russian  
No 3, Mar 89 pp 7-10

[Article by A. G. Lavrov, A. V. Shchukin]

[Abstract] This article analyzes the influence of the fundamental magnetic fluid parameters on the magnetic field in the gap of an asynchronous motor and the inductive impedances of its windings. The study derives expressions that make it possible to represent the magnetic field induction in the asynchronous motor gap by a set of rotating harmonics. The drop in the magnetic field in the asynchronous motor gap when the magnetic fluids are used is then estimated. The effect of the magnetic fluids on the inductive impedances of the asynchronous motor windings is also considered. The inductive scattering impedances of the asynchronous motor windings are found to increase when magnetic fluids are used in the asynchronous motor due primarily to an increase in flank scattering. The analysis carried out here suggests that the use of magnetic fluids in the inner volume of an asynchronous motor will serve to reduce the reactive component of the magnetization current and will increase the inductive impedances of flank scattering.

**A Thyatron Motor for Robot Drive Applications**

18600184b ELEKTROTEKHNIKA in Russian  
No 3, Mar 89 pp 28-32

[Article by V. D. Kosulin, G. B. Mikhaylov]

[Abstract] This article analyzes d.c. thyatron motors for application to robot drives. Thyatron d.c. motors, which have the mechanical and control properties of collector motors, have a reliability comparable to that of a.c. generators and since they employ a semiconductor commutator the thyatron motors can be used to significantly expand the range of optimum control principles and thereby improve the power characteristics of the robot drive systems. The article analyzes various d.c. thyatron motor designs and compares the performance and operating characteristics of such thyatron motors to other possible robot drive motor designs. Coil graded thyatron motor designs receive special attention. The coil graded thyatron motors examined in the article can be recommended for robot drive applications in view of their capacity to deliver a constant (with a known degree of accuracy) power to the shaft and due to their enhanced start-up and power properties for specific applications where the industrial process requires a moving element to be transported over substantial distances with a minimum transit time.

**Performance Analysis of High-Precision Inductive Shaft Digitizers**

18600184c ELEKTROTEKHNIKA in Russian  
No 3, Mar 89 pp 36-40

[Article by V. V. Khrushchev, V. N. Levitskiy, A. G. Fedorenko]

[Abstract] This article calculates the precision characteristics of inductive shaft digitizers for synchronous transformer angle transmission conditions; in this case the magnetic flux and output voltages are determined by numerical techniques, while the magnetic field distribution in the air gap is determined by a grid electric-analog model. The article carries out calculations of the magnetic field, the total flux, the correction to the spatial harmonics of the output voltages, and the precision characteristics of the inductive shaft digitizers. The adequacy of the mathematical model is evaluated. The study concludes that accounting for the edge flux loss effect improved the reliability of the total flux calculation between the magnetic circuits of the rotor and the stator. The combined use of the electric analogies and gear conductances for calculating the total flux expands the capacities of each technique and produces a calculation error comparable to that of the magnetic field calculation. The minimum error of the inductive shaft digitizers in transformer synchronous angle transmission for the two calculated parameter ratios did not exceed four angular seconds while the second configuration of the magnetic circuits is less sensitive to industrial fabrication errors of the gear area.

**High-Temperature, High-Speed Compact Gallium Arsenide Diodes**

18600184d ELEKTROTEKHNIKA in Russian  
No 3, Mar 89 pp 72-74

[Article by A. S. Ardzhanov, O. M. Pishchko, A. A. Slutskiy, V. Ya. Stoyanovskiy]

[Abstract] This article reports the development of high-temperature high-speed compact GaAs diodes operating at currents up to 200 amps and voltages of 1000 V. These diodes have been designated as the DAG-200 GaAs diodes and have superior performance characteristics compared to silicon diodes operating at the same current. The DAG-200 diodes are designed for operation in static d.c. and a.c. converters at elevated temperatures and at frequencies up to 100 kHz which require short recovery times, and in pulse devices as well. The diodes are fabricated in metallic-glass packages and have the following primary specifications: Forward pulse voltage, volts: 1.6 to 1.8; pulsed reverse current, mA: 10, 1 (for junction temperatures of 240°C and 25°C, respectively); reverse recovery time at  $t$  equals 240°C: 0.2-0.63 mcs; junction-package thermal resistance, °C per W: 17. The performance data provided in the article for the DAG-200 diodes and their comparison to silicon analogs demonstrates the promise of the DAG-200 diodes for power semiconductor electronics for expanding the

capabilities of power converters and improving their cost and engineering characteristics.

### Calculation of a Fiber Lens for an X-Ray Continuous Film Recorder

18600186a Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII in Russian Vol 34 No 2, Mar-Apr 89 pp 85-89

[Article by A. B. Chigorko]

[Abstract] This article is devoted to the design of a fiber lens for an X-ray continuous film recorder and provides equations for calculation of the fiber lens together with an evaluation of the primary specifications of the film recorder unit. The equations derived in this study can be used to calculate the performance of the fiber lens in the X-ray continuous film recorder. The lens shape and the position of the optical fibers within the lens support uniform scanning for the case of contact image transfer from the luminescent screen onto the film. The derived equations can also be used to formulate a computer-aided design algorithm and for designing devices for X-ray imaging units.

### The Noise Level in Coherent Photographic Processing Systems

18600186b Moscow ZHURNAL NAUCHNOY I PRIKLADNOY FOTOGRAFII I KINEMATOGRAFII in Russian Vol 34 No 2, Mar-Apr 89 pp 94-98

[Article by A. V. Belinskiy, M. I. Dubova, A. V. Plokhov, E. Yu. Yuzapavichyus]

[Abstract] This article is devoted to formulating a technique for calculating parasitic reflection noise in coherent photographic processing systems and to optimizing aberrational distortions. The analysis focuses on the calculation of noise attributable to parasitic reflections off of optical surfaces whose primary source is the surfaces bounding the air. The article proposes an objective and optical scheme for analyzing the appropriate noise levels and an analysis suggests that the noise intensity from such an objective is substantially lower (more than two orders of magnitude) than the legitimate signal. It is established that due to the positive sum focal power of the objective, its focal power for the noise beams as a rule exceeds the focal power for the signal beam due to the double transmission of the positive components. In this scheme the greater this difference the higher the signal-to-noise ratio due to the diminishing noise intensity. This analysis suggests that two the degree possible the reflecting "noise" surfaces should have a positive focal power for the corresponding noise beams. The optimum objective design from this viewpoint would be one in which the first and last surfaces bounding the air are convex.

### Optimum Design Decomposition for Multichannel Servosystems

18600187a ELEKTRICHESTVO in Russian No 3, Mar 89 pp 19-25

[Article by B. I. Kuznetsov]

[Abstract] This study derives optimum operators for optimization of multichannel servosystems. The study carries out a numerical analysis to derive the simplest algorithm making it possible to obtain a sufficiently close approximation to an optimum algorithm. This algorithm is the first iteration over the entire set of channels where the channel operators are synthesized in the space of channels in increasing order of the channel index beginning with the first index and ending with the last index. In this case it is necessary to minimize the error dispersion of the K-channel system. The problem is reduced to synthesizing an optimum regulator for a single-channel stabilization system. The proposed algorithm is then used to synthesize optimum operators for a two channel servosystem for measuring the position of mobile objects. The derived optimum operators are then implemented by means of modal control techniques. A comparison of the dispersion values indicates that the optimum channel operators are suitable for application. The optimum synthesis decomposition routine used in this analysis is also useful when it is important to obtain an acceptable solution when there are shortages of computer power, time, or hardware for designing the regulators, which is important for on-board control systems.

UDC 620.179.15

### Information Yield of Wideband Radio-Wave Methods of Inspecting Multilayer Dielectric Structures

18600201a Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 89 pp 48-57

[Article by A. M. Akhmetshin, Dnepropetrovsk State University imeni Tricentennial of Reunification of Ukraine with Russia]

[Abstract] Introspect of multilayer dielectric structures by wideband radio-wave methods is analyzed for the information content about the properties of such structures, namely thickness and dielectric permittivity of each layer. There are two methods involving transition from the frequency domain to the time domain. In the first case one measures the frequency dependence of the complex reflection coefficient and then describes the properties of the structure in the time domain on the basis of the oscillatory pulse response. In the second case one measures the frequency dependence of the modulus squared of the complex reflection coefficient and then describes the properties of the structure in the time-delay domain, not in the real-time domain, on the basis of the oscillatory autocorrelation function of the pulse response. Methods based on parametric optimization of



the mathematical model involve estimation of parameters followed by statistical analysis for standard deviation and relative error. Calculations made for a two-layer dielectric structure and inspection by each method of several different structures without substrate indicate that most sensitive to variation of a property and thus most informative about it are its phase-frequency and phase-time characteristics. Most expedient is basing the interpretation of measurements in the time domain on the complex envelope of the analytical pulse response or of the pulse response's analytical autocorrelation function. Using the phase-time characteristic of the complex envelope of that autocorrelation function will enhance the information content of readings obtained by variable-frequency radio interference measurements. Figures 2; tables 2; references 8; Russian.

UDC 620.179.18:778.38

### Holographic Nondestructive Inspection of Composite Cylindrical Shells

18600201b Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 89 pp 58-63

[Article by Ye. N. Denezhin, S. P. Ilinykh, and V. A. Khandogin, Novosibirsk Institute of Electrical Engineering]

[Abstract] Nondestructive inspection of composite cylindrical shells with a reinforcing metal ring by the method of double-exposure holographic interferometry is described, the main defect in such a shell being a poor joint between the lateral wall and the ring. Such a defect can be detected only on the basis of anomalous strain concentrations, locating which requires precise quantitative decoding of holographic interferograms for reconstruction of displacement and strain distributions. The inspection apparatus consists of a CAMAC crate, a holographic interferometer with an electromechanical device for input of optical data to the CAMAC crate, a color television receiver with a CDR drive, a black-and-white television receiver with a DTV drive, both drives controlled by the CAMAC crate, a 4x64 kbyte random-access memory interacting with the CAMAC crate, also an MS 1201.02 microcomputer and a 15 IZ-00-015 control terminal and a DL plus DL C/S data link to an SM 1420 host minicomputer interacting through a common busbar interfaced with the CAMAC crate. The interferometer includes three lasers spaced 120 deg apart around the inspected shell, each light beam striking its surface at a 5 deg incidence angle and being reflected at the same angle onto a holographic plate. This configuration makes the interferometer sensitive to deflection only, flexural strain being more informative than membrane strain under excess internal pressure. Interferograms are decoded by homomorphous filtration of the luminance field. The apparatus and the method were tested on typical shells and found to be very effective, also sufficiently productive. Figures 5; references 1; Russian.

UDC 620.179.13

### Automatic Pass-or-Reject Tester for Nondestructive In-Process Inspection by Heating Method

18600201c Sverdlovsk DEFEKTOSKOPIYA in Russian No 3, Mar 89 pp 91-93

[Article by V. A. Storozhenko, V. A. Kon, and Z. V. Ivanishina, Kharkov Institute of Radioelectronics imeni Academician M. K. Yangel]

[Abstract] An automatic pass-or-reject tester has been built for nondestructive in-process inspection of terminal insulation, specifically thermos insulation, with a contact-making thermal defectoscope. The inspection is a cyclic operation, the cycle time ranging from 10 s to 200 s depending on the product. The tester operates in the storage mode and in the decision mode. It includes a reference thermos with a temperature transducer, two timers controlling the storage mode of operation with time delay adjustable over the 10-200 s range, a sequential analog-to-digital converter with an input amplifier, a register with a memory, a digital indicator with readout in the octal code, a comparator, a red "reject" lamp and a green "pass" lamp, their glow period being set by a third timer, and a buffer amplifier igniting whichever lamp it should. The tester requires a 36 V—50 Hz power supply and draws 25 W. It has passed acceptance tests for continuous inspection on a trial basis in a production plant. Figures 1; tables 1; references 2; Russian.

UDC (621.313.025:536.483).001.2

### Optimal Designing of Cryogenic A.C. Electrical Machines

18600235a Moscow ELEKTROTEKHNIKA in Russian No 5, May 89 pp 25-29

[Article by A. M. Rubinraut, candidate of technical sciences, V. D. Rozenknop, engineer, and P. A. Matveychuk, engineer, All-Union Scientific Research Institute of Electronic Machine Design]

[Abstract] A mathematical model of a cryogenic a.c. machine is constructed for computer-aided determination of its optimum geometrical dimensions and other design parameters, considering inclusion of a cryostat for the superconductor coils and absence of an iron armature core. Supply voltage and power output are fixed. Frequency and speed may be fixed or variable. Diameters, lengths, widths, number of pole pairs, armature current density, and specific linear loading are variable. The design proceeds according to standard procedure for an electrical machine plus cryostat and optimization involves minimizing the penalty function added to the target function. The results of such a design are demonstrated on a cryogenic 14 MW—120 rpm motor driving a container ship and supplied from a 6.3 kV alternator through a frequency converter on board. As target function is selected the specific volume ( $\text{m}^3/\text{MW}$ ) and the

limiting constraints in the penalty function are maximum temperature of armature winding, maximum temperature of ferromagnetic shield, core length determined by shock and vibration resistance, outside diameter of cryostat, helium flow rate determined by cooling requirement, minimum clearance between armature conductors, cost of superconductor material, efficiency, maximum transient reactance determined by frequency

converter switching requirements, field current, efficiency, and minimum clearance between armature-winding bars. The results indicate, among others, a strong dependence of the necessary helium flow rate on the machine dimensions. A four-pole machine is selected as most expedient initial choice and found to require 1.7 m<sup>3</sup>/MW with an outside diameter of 1.25 m. Figures 4; tables 1; references 9: 8 Russian, 1 Western (in Russian translation).

**Results From an Analysis of a High-Voltage  
Multibeam Electron-Optical Centrifugal  
Electrostatic System**

18620148i Moscow *RADIOTEKHNIKA I  
ELEKTRONIKA in Russian*  
Vol 34 No 2, Feb 89 pp 435-438

[Article by L. I. Andrikanis, N. S. Bunina, M. Z. Melikov]

[Abstract] This study provides results from a theoretical analysis and experimental investigation of a multibeam electron-optical system with a high-voltage gap length of up to 7 cm employing centrifugal electrostatic formation of electron fluxes and designed for a high-voltage electron-beam rectifiers. The primary element of such a multibeam electron-optical system is a module generating two diverging strip-type electron fluxes. The module includes two cathodes, accelerating anodes, and protective electrodes. In this design it was necessary to alter the electrode shape in order to simplify the fabrication and assembly technology of the electron-optical system. The study provides the I—V characteristics of the two-beam electron-optical system module together with results of the calculation of the current cut-off mode in the electron-optical system.

**Recommendations for Specifications and  
Guidelines on Electrical Lighting**

18600250a Moscow *SVETOTEKHNIKA in Russian*  
No 6, Jun 89 pp 26-27

[Article by S. A. Klyuev]

[Abstract] This article discusses the recommendations underlying the specifications and guidelines for electrical lumination based on the "Instructions for Drafting and Formulating Electrical Engineering Documentation for Industrial Construction": VSN 381-85/MMSS of the USSR. The working documentation for electrical lighting includes the following specifications and lists: equipment specifications, material requirement list, assembly components and parts list, materials and parts list, construction and assembly list. The article provides sample forms for each of these classes and outlines the procedures for filling out and submitting the forms as well as relevant exceptions and standard practices.

**Seminar on Light Sources**

18600250b Moscow *SVETOTEKHNIKA in Russian*  
No 6, Jun 89 pp 30-31

[Article by G. I. Ashkenazi]

[Abstract] This article is devoted to a review of the one day seminar entitled "High-Pressure Gas Discharge Light Sources and Their Application" held in Moscow on February 6, 1989. This seminar was sponsored by the light engineering division of the Moscow Administration of the All-Union Scientific and Technical Society of Power Engineers and The Dzerzhinskiy House of Scientific and Technical Propaganda. One hundred sixty specialists from 87 industrial enterprises and 63 scientific research, design, and other organizations from Moscow and the Moscow region participated in the conference. The conference proceedings included papers devoted to several subjects in light engineering and lighting equipment. The topic papers included: "Metal Halogen and Sodium Gas Discharge Lamps and Their Application"; "Application of Xenon Gas Discharge Lamps in Industrial Processes"; and "The Application of High-Pressure Mercury Gasdischarge Lamps in Medical Practice."

**A Mathematical Model of the Current and  
Potential Density Distribution in High-Power,  
High-Voltage Transistors**

18600255a  
*ELEKTROTEKHNIKA in Russian* No 6, Jun 89 pp 25-30

[Article by V. A. Belyakov, V. A. Rudskiy, V. V. Togatov]

[Abstract] This article proposes a mathematical model of the stationary current and voltage density distribution across the area of the emitter and base strips of a high-power, high-voltage transistor for various transistor operating conditions and injection levels. The analysis concerns a standard  $n^+p-n^+$  high-power, high-voltage transistor structure. The model makes it possible to establish the interrelation between the current distribution and both the structural and physical parameters of the transistor structure, including the parameters of the  $n^+n^+$  collector junction. The derived formula completely describe the current and voltage distribution between the elementary transistors within the structure in both active and quasisaturation conditions and also make it possible to account for the effect of dynamic electron charge in the collector. The article provides primary calculation results for various voltage levels and conditions in the  $n^+p-n^+$  transistor structure. The appendix to the article considers the dependence of the collector modulation factor on the operating conditions of the  $n^+p-n^+$  transistor structure with a graded  $n-n^+$  junction.

### The K1813 Series Single-Chip Microcomputers

18600194; *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 74-75

[Article by M. I. Maslov, V. V. Pavlov]

[Abstract] This article reports the development of the K1813 series integrated circuits; this circuit is a programmable digital analog signal processor designed for real-time systems. The devices contained on the chip, including analog-to-digital and digital-to-analog converters, a central processor, a UV erasable PROM and RAM form a device capable of performing such functions as signal filtering, modulation, detection, and limiting. The speed necessary for real time processing is provided by simultaneous operation of the digital and analog circuits of the chip. A nine-bit digital-analog register provides the interface between the analog and digital sections of the chip. The K1813 processor employs a pipeline architecture and an original multiplication algorithm requiring less time than the shift and addition algorithm traditionally used in microprocessors. The chip specifications included: word size, arithmetic logic unit, bits: 25; UV erasable PROM capacity, bits: 192 by 24; RAM capacity, bits: 40 by 25; permanent memory capacity, bits: 16 by 4; Input-output lines: 28; instruction cycle duration, ns (at a clock frequency of 6.67 MHz): 600. The IC is delivered in the standard 2121.28-6 package with 28 pins. The instruction set consists of eight primary arithmetic and logic instructions and 6 analog instructions. The K1813 single-chip integrated circuits can be used for such complex devices as modems, correlators, generators, and controllers for process control systems etc.

### Series KM1804 Large-Scale-Integrated Set of Microprocessor Chips

18600240; *Moscow RADIOOTEKHNIKA in Russian*  
No 5, May 89 pp 72-74

[Article by M.I. Maslov and V.V. Pavlov]

[Abstract] The series KM1804 LSI set of microprocessor chips is designed for use in equipment ranging from microcontrollers to high-speed microcomputers and minicomputers. It is based on SchTTL technology and pipeline data processing. It is universally microprogrammable. Its 21 different chips include two arithmetic-logic units, one basic and one with expanded options, a fast-transfer circuit, a state and shift control circuit, two microcommand address control units and a microcommand address control circuit, a next-address selection control circuit, vectorial priority interrupt and interrupt expansion circuits, one of each, three transceivers, two plain and one with interface logic, a parallel bidirectional counter, a clock generator, a program-storage address control unit, an error detection and correction circuit, two parallel registers, a peripheral microprocessor, and a RAM control circuit. Accessories available for debugging and adjustment of microprocessor systems based on this KM1804 set are the Elektronika MT 1804 training

microsimulator for study of system architecture and programming techniques, the GNOM object microcode generator and the SLOT logic debugging software written in FORTRAN into the RAF Operating System compatible with SM-4 and Elektronika-100/25 minicomputers, and the KRAS program debugging software written in AMDASM host language on a Unified System computer but compatible with P1804 language. Tables 2; references 4; Russian.

### Serial Interface Controller

18600252; *Moscow RADIO in Russian*  
No 6, Jun 89 pp 38-42

[Article by A. Dolguy]

[Abstract] This is one of two articles devoted to a serial interface controller employed to provide an interface between the "Radio-86 RK" computer with any peripheral. This controller can be used to provide access to a computer network or a computer equipped with the controller can itself be used as a portable terminal for a mainframe computer. The controller consists of two sections. The first section converts information from the computer into a serial code and performs the reverse conversion as well. All input and output signals are generated on the standard logic levels. The second section provides electrical compatibility of the inputs and outputs of the first section with specific peripherals. The main controller chip is a KR580VV51 universal synchronous-asynchronous transceiver chip. In addition to wiring and schematic diagrams of the serial interface controller the article provides the port breakout and the pin maps for the integrated circuits. Several possible hook-ups of the serial interface controller are discussed as well as the relevant connections and modifications necessary to support operation.

### The Concept of an Emergency Failure in Microprocessor Systems

18600269; *Moscow AVTOMATIKA TELEMETRIKA I SVYAZ in Russian* No 7, Jul 89 pp 22-25

[Article by V. V. Sapozhnikov, V. V. Sapozhnikov]

[Abstract] This study classifies and analyzes emergency and nonemergency failures in microprocessor systems used in railroad traffic automation. An emergency failure is classified as a failure that may have emergency consequences (resulting in accidents or major material losses). The analysis establishes a mathematical definition for this concept and identifies the features of emergency failures in microprocessor systems. Graph theory and predicate logic are used in the analysis. An examination of emergency program defects suggests that the concept of an emergency software failure is identical to the concept of an emergency hardware failure. This is because from the functional viewpoint the management program is equivalent to a finite automaton. The study therefore defines a program failure as an emergency failure if certain specified conditions are satisfied for the



control algorithm in the event of such a failure. It is also established that software is substantially "richer" than hardware from the viewpoint of failure consequences.

Many program failures do not have analogs in hardware. Hence, the problem of developing safe software is much more difficult.

UDC 538.567

### Classical Microwave Mixer Built on Pb Superconductor-Insulator-Superconductor Junctions

18600063a Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 58 No 8, Aug 88 pp 1546-1548

[Article by A. V. Poladich and L. P. Strizhko, Institute of Radio Astronomy, UkSSR Academy of Sciences, Kharkov]

[Abstract] An experimental study of superconductor-insulator-superconductor junctions operating as classical microwave mixer as well as quantum mixer device in a receiver was made. Pb as electrode material being most suitable for matching the normal resistance  $R_N$  as well as the capacitance  $C$  of such a junction to both the microwave channel and the intermediate-frequency channel. Specimens of such junctions with a surface area  $S$  of  $(1-2) \cdot 10^{-6} \text{ mm}^2$  were produced by deposition on mica through masks, a tunnel barrier being formed by oxidation in air. These junctions with  $R_N S$  of  $(250-500) \cdot 10^{-6} \text{ ohm} \cdot \text{mm}^2$  and  $C$  equal to  $0.04 \text{ S pF}$  were placed inside a mixing chamber, the latter made up of waveguide segments coupled through exponential compensating transition pieces, for measurement of the VSWR and the attenuation over the 30-39 GHz frequency range at 4.2 K and 1.8 K temperatures. The performances characteristics were found to be satisfactory for operation of such junctions as classical tunable mixer with a low-noise intermediate-frequency amplifier. Their noise temperature, determined by shot noise, was approximately 10 K. The authors thank A. M. Korolev for supplying the intermediate-frequency amplifier. Figures 2; references 5: 1 Russian, 4 Western.

UDC 538.566.5

### Extraction of Microwave Energy From Plasma Waveguide

18600063d Leningrad ZHURNAL TEKHNIЧЕСКОY FIZIKI in Russian Vol 58 No 8, Aug 88 pp 1637-1639

[Article by G. I. Zaginaylov, A. N. Kondratenko and Ye. M. Prokhorenko, Kharkov State University imeni A. M. Gorkiy]

[Abstract] The problem of extracting microwave energy from a plasma waveguide is solved theoretically, which confirms the feasibility of plasma-beam interaction instability as a source of electromagnetic radiation. A straight cylindrical plasma waveguide inside a gradually widening metal pipe and thus with a correspondingly widening vacuum gap between them is proposed, instead of using a relativistic electron beam so as to reduce the extraction losses but at the expense of a high input energy. The pipe profile can be designed for minimum reflection loss over a wide operating frequency range, while ensuring that the phase velocity of the propagating

surface wave increases while the quasi-longitudinal electromagnetic field at the origin of the structure transforms into a quasi-transverse one at the exit. A large increase of the phase velocity is possible when the plasma lies far above the operating frequency range. The problem of maximizing the extraction efficiency reduces to calculation of the reflection coefficient by the method of cross-sections and minimizing it for the shortest possible waveguide while simultaneously solving the dispersion equation for a surface wave in such a waveguide. Figures 1; references 5: Russian.

UDC 621.385.69.01

### Constraints on Optimization of Parameters of Gyrotrons With Competing Modes

18600188d Moscow RADIOTEKHNIKA I ELEKTRONIKA in Russian Vol 34 No 3, Mar 89 pp 649-652

[Article by G. S. Nusinovich, A. B. Pavelev and V. I. Khizhnyak]

[Abstract] Design of a gyrotron with fully developed interaction space is considered, the aim being to ensure stable single-mode operation without competing other modes. Calculations based on a nonequivalent spectrum of natural frequencies of competing main mode and nearest parasitic ones yield the self-excitation zone for parasitic modes in the "electron beam current—mode propagation angle" plane and its boundaries in the "electron beam current—referred cavity length" plane, the critical mode propagation angle corresponding to the minimum starting current for a parasitic mode. They also yield the dependence of both single-mode gyrotron efficiency and critical frequency deviation on the referred cavity length, and isoefficiency lines in the "electron beam current - referred cavity length" plane. These calculations are made in the kinematic approximation, ignoring the variance of velocities and radii within the electron beam, for a continuous-wave gyrotron and for a pulsed one. The results reveal a different optimum range of cavity length for each and the constraints which avoidance of parasitic modes imposes on the maximum attainable efficiency in each case. Figures 3; references 7: 5 Russian, 2 Western.

UDC 621.396.43

### Millimetric-Wave Radio Relay Lines With Antennas Mounted on Towers of Electric Power Transmission Lines

18600210d Moscow IZVESTIYA AKADEMII NAUK SSSR: ENERGETIKA I TRANSPORT in Russian No 2, Mar-Apr 89 pp 98-102

[Article by P. Ya. Golov, R. G. Knizhnik, and A. N. Kochubey, Kiev]

[Abstract] The performance of millimetric-wave radio relay lines with transmitter and receiver antennas

mounted on towers of high-voltage electric power transmission lines is analyzed for signal fadeout as a result of scattering of radio waves by power lines. Theoretical relations leading to the Poynting vector for radio wave power scattered prior to signal arrival at the receiver antenna are derived in a cylindrical system of coordinates around a transmission line conductor along the axis. Calculations are made for a radio wave polarized with a horizontal E-vector and impinging on a transmission line conductor at an arbitrary angle, the conductor being a quasi-ideally conducting one above a smooth ground surface. Numerical results pertaining to an 8.6 mm radio wave reaching the receiver antenna mounted on top of a 35 m high 330 kV transmission line tower, 5 m above a 10 km long transmission line conductor so that the latter does not obstruct the first Fresnel zone, indicate that signal fadeout owing to interference by power lines is negligible in such a configuration and that the principal cause of signal fadeout is reflection by a smooth ground surface. This fadeout is shown to be minimized by a vertical plane rectangular metal shield perpendicular to and symmetric with respect to the line connecting the projections of transmitter antenna and receiver antenna onto the ground surface, mounted at a distance from the point of geometrical reflection which corresponds to complete shielding of the reflected wave. Figures 1; references 15: 8 Russian, 7 Western (4 in Russian translation).

#### **The Narrowband Radiation Component in the Flash Phase of a Microwave Flare**

18600226e Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY RADIOFIZIKA in  
Russian Vol 32 No 4, Apr 89 pp 516-518

[Article by B. N. Levin, V. M. Fridman, O. A. Sheyner]

[Abstract] This study analyzes the spectral and temporal properties of solar radio emission flares in the 8 to 12 GHz range in order to investigate the dynamics of the flash component of radiation. The observational data were recovered in November of 1981 on the RT-22 (angular resolution of approximately 4.5 to 6 minutes) using a universal serial analysis solar spectrograph allowing measurement of the spectrum of incoming radiation at a sweeping rate of a single spectrum per second and with a frequency resolution of approximately 100 MHz. The analysis was based on observational data on seven radio emission flares whose characteristics are discussed in the article. The article also provides a time plot of the flare at a fixed frequency; second by second increment spectra; and the detected narrowband flash radiation (event A) for the radio flare of November 14, 1981 at 10 hours 18 minutes Universal Time. Tables are given that provide the primary properties of the flash narrowband radiation identified here, including the number of elementary events, their intensity, the drift rate, and the bandwidth. The elementary flare events in microwave flare radiation can be described based on both plasma and quasilinear generation mechanisms developed within the framework of existing models. The

study demonstrates that by observing the "plasma line": a narrowband component with frequency drift it is possible to diagnose such parameters of flare loops as the concentration and scales of plasma inhomogeneity in the vicinity of the radiation source as well as the transverse dimensions of the area of energy release.

#### **Use of Microwave Energy in Agriculture**

18600254a Moscow ELEKTRICHESTVO in Russian  
No 6, Jun 89 pp 1-8

[Article by I. F. Borodin]

[Abstract] This article discusses microwave power engineering for generating electricity used in agriculture. The importance of electricity in future agricultural developments is emphasized. The increasing industrialization of agricultural processes will require readily available electricity and in view of the diminishing supply of fossil fuels electrical power generation is viewed as the most promising form of energy for agricultural applications. The article discusses the features of microwave power engineering that differentiate this field from standard power engineering. Such aspects include high concentration of electromagnetic energy in small volumes, the absorption of microwave energy by an entire body independent of the shape or dimensions of the treated material, high efficiency of microwave-to-thermal energy conversion, etc. Specific applications of microwave power engineering in agriculture include applications in plant growth and seed testing, soil treatments, disinfection, microwave drying, as well as microwave applications in livestock management. Microwave power can also be used to evaluate the frost resistance of vegetation and for sorting of agricultural produce and related products.

UDC 621.385.624.01

#### **Efficiency-Optimized Relativistic Multiple-Resonator Klystrons with Distributed Energy Takoff**

18600259E Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 34 No 6 Jun 89 pp  
1255-1263

[Article by A. V. Aksenich, I. G. Artyukh, S. V. Kolosov]

[Abstract] Relativistic multiple-resonator klystrons are used to produce high power microwave oscillations. Due to the limited gap length in the output resonator, the RF field intensity in the gap may exceed the breakdown value, preventing the production of high output power energy. This article suggests a distributive device to be used to take off energy from independent resonators, not only decreasing the intensity of the field in the gap, but also increasing the efficiency of the device by 3-7 %. The parameters of the klystron were optimized in stages, yielding an efficiency of 80-90 % in 3-5-resonator units

with a power gain of 50-60 and reduced maximum field intensity in the gap. Figures 5; References 2 Russian.

06508

UDC 621.385.6.01

### **Multistage Frequency-Doubler Klystron With Transverse Modulation**

18600266b Minsk DOKLADY AKADEMII NAUK BSSR in Russian Vol 33 No 7, Jul 89 pp 614-616

[Article by A. A. Kurayev and A. K. Sinitsyn, Minsk Institute of Radio Engineering]

[Abstract] Inasmuch as cascade frequency-doubler klystron with transverse modulation can be made shorter than a conventional one and the electromagnetic field which phase-modulates the relativistic electron beam in the input cavity with a nonuniform magnetostatic field need not have as large an amplitude, there are three ways to maximize the efficiency of such a klystron: 1) using

the  $E_{110}$ -mode of a circular cavity coaxial with the klystron rather than the  $H_{101}$ -mode of a rectangular cavity in the modulating stage will minimize the modulation losses; 2) cascading the modulator with an idle similar second modulating cavity excitable by the spatially modulated relativistic electron beam will increase the gain; 3) addition of cascaded bunching cavities tuned to the second-harmonic frequency behind the main bunching space will improve the bunching pattern. The effectiveness of all three design features combined in a six-cavity klystron with transverse modulation has been evaluated by numerical simulation and optimization on the basis of a physical klystron model and a mathematical beam-field interaction model, with the intrinsic field of the relativistic electron beam taken into account. The results indicate that such a klystron only two thirds as long as a conventional one with the same number of stages will have about the same efficiency and an up to 20 pct higher gain. Article was presented by Academician V. A. Labunov, BSSR Academy of Sciences. Figures 1; table 1; references 2; Russian.



### **Analysis of the Spatial-Polarization Parameters of RF Signals by Simulation Detector**

18620127d *RADIOTEKHNIKA in Russian*  
No 1, Jan 89 pp 41-43

[Article by V. F. Komarov, V. V. Nikitchenko, P. S. Vikhlyantsev]

[Abstract] This article proposes a technique for analyzing a simulation algorithm based on the weight coefficients of an adaptive antenna system and illustrates the use of this technique in estimating range and polarization. This analysis of spatial-polarization simulation algorithms bases the estimate of the spatial-polarization parameters of the RF signals on a generated weight coefficient vector. The analysis is broken down into the following stages: 1) incorporating the specific antenna system structure (the number of antenna elements, their configuration, polarization, and directional properties); 2) representation of the signal-interference conditions; 3) determination of the covariant matrix of received signals; 4) representation of the reference vector which determines the initial directional pattern of the adaptive antenna systems and their dependence on the spatial-polarization parameters; 5) calculation of the optimum weight coefficient vector; 6) simulation of a signal with given spatial-polarization parameters; 7) calculation of the dependence of the output signal on the spatial-polarization parameters; and 8) investigation of the extrema in the derived relation. The analysis indicates that adaptive antenna systems allow estimation of the spatial-polarization parameters in complex signal and interference conditions. The recoverable information from the weight coefficient vector is determined by the structure of the antenna system. One advantage of this technique is that it can produce a rather accurate estimate of the spatial-polarization parameters without disrupting the primary operating conditions of the adaptive antenna systems.

### **Shortened Serial Signal Detector Routing**

18620127e *RADIOTEKHNIKA in Russian*  
No 1, Jan 89 pp 50-52

[Article by I. A. Nugmanov]

[Abstract] This article examines one possible approach to the problem of formulating boundaries on an abbreviated signal detection routine for detecting a known signal against an interference background of fixed energy with a small sampling size. The article provides a sample calculation of signal detection thresholds in the presence of normal white noise. In order to test the calculation results the abbreviated detection routine is analyzed statistically on a computer using the same parameters as in the calculation. The given error probabilities are then used to formulate the abbreviated serial analysis of the verification of the statistical hypotheses based on independent tests.

### **The ALS-YeN Automatic Locomotive Signalling System**

18600133a *Moscow AVTOMATIKA*  
*TELEMEKHANIKA I SVYAZ in Russian*  
No 1, Jan 89 pp 8-12

[Article by V. M. Lisenkov, S. P. Shurygin, I. V. Belyakov, D. V. Shalyagin]

[Abstract] This article is one in a series of articles devoted to the ALS-YeN automatic locomotive signalling system. The present article focuses on the electromagnetic compatibility between railroad equipment and the rail circuits. This analysis accounted for the necessity of a quantitative estimate of the effect of analog communications equipment on railroad receivers in normal operation and the maintenance of the standard operating conditions of the rail circuits for the case when the analog transmitters are connected on both the supply and relay ends. The analysis discusses the stringent electromagnetic compatibility requirements imposed on the protection and junction devices designed for electrical isolation of the rail circuit signal transmission channels, the ALSN and ALS-YeN systems during their joint operation. The article carries out a detailed analysis of the residual voltage and current levels on the route circuits and standard voltage levels at various points in different climatic conditions. The effect of shunts on the rail end and the feed end are discussed. The devices and specifications outlined in the article can be used to assure joint operation of the equipment without electromagnetic interference.

### **Start-Up of the Line Circuits in the IKM-120 Transmission System.**

18600133b *Moscow AVTOMATIKA*  
*TELEMEKHANIKA I SVYAZ in Russian*  
No 1, Jan 89 pp 13-15

[Article by V. P. Glushko, S. Ye. Kustyshev, A. P. Koshelev, A. D. Baranenko]

[Abstract] This is one in a series of articles devoted to the line circuits in the IKM-120 transmission system. Previous articles provided descriptions of the design of the digital line circuit together with measures for the start-up of the terminal equipment in the IKM-120 transmission system. The present article considers the primary elements in the start-up in of the line circuits of this transmission system. The line circuits in the IKM-120 transmission system include the repeater sections, attended and unattended repeater stations, and the cable equipment at the terminal exchanges. The start-up of these line circuits is divided into three primary stages: the preparation and testing of line-cable structures; the testing and installation of repeaters on the line, and the comprehensive testing of the line circuit. In addition to the line circuit test and measurement procedures the article provides nominal signal levels at various frequencies on different cable line pairs.

**Methods of Eliminating Deficiencies in the Antenna Match of Standard Railroad Radio Sets**

18600133c Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian  
No 1, Jan 89 pp 20-21

[Article by S. I. Tropkin, T. V. Klimova]

[Abstract] This article reports two primary design deficiencies in the antenna match employed in standard railroad radio sets. One of the deficiencies causes matching and tuning errors. The article identifies a lack of logical correlation between the printed positions of switch B1 ("coupling control") and the actual degree of coupling between the feed circuit and the load. In order to eliminate this deficiency it is recommended that switch B1 be set in position 11 so that the coupling between the load and the feeder is minimized. The antenna circuit is then tuned thereby compensating the reactance of the load making it possible to increase the coupling (by setting switch B1 to position 9, 8, etc.) and achieving equality between the load resistance and the wave impedance of the feeder. The second design deficiency of the antenna match is one that precludes optimum matching of the load to the transmitter for the case where the load resistance exceeds 75 ohms. Matching in this case can be achieved by using an antenna match with a variable conversion factor. The article discusses changes that must be made in the antenna match to accommodate this modification.

**Fault Transformation in Communications Cables Railroad Radio Sets**

18600133d Moscow AVTOMATIKA  
TELEMEKHANIKA I SVYAZ in Russian  
No 1, Jan 89 pp 27-30

[Article by A. I. Kurilo]

[Abstract] This article discusses the procedure of fault transformation for application to communication cables. Fault transformation is an operation that involves converting faults that elude detection into "shorted conductor" or "break" faults. Faults that are difficult to detect a drop in cable conductor insulation resistance to 10 to 50 Mohms; intermittent conductor shorting or contact loss in the line, and irregularities in the geometric dimensions of the core. This article proposes two attachments for performing fault transformation: a unit for welding conductors at sites of low electrical insulation strength and a device for testing cable sections having resistance asymmetry. The former device consists of a power transformer with four windings. The high power level in the system makes it possible to obtain a stable electrical arc between the two conductors at the fault position in the case of failure outlined above. The device used to test cable sections with resistance asymmetry is similar to the device described above. The difference is that the latter device employs rectifier diodes with a 1.5 amp nominal current and the limiting

resistor can also be disconnected. In addition to schematics and measurement schemes this article reports the test results from the use of these two devices.

**Automated Directory Assistance Service for Municipal Telephone Networks**

18600135a Moscow VESTNIK SVYAZI in Russian  
No 1, Jan 89 pp 35-36

[Article by V. N. Podshibikhin]

[Abstract] This article discusses the design and procedures of the automated directory assistance service used on the Gorky municipal telephone network. This directory assistance service handles requests for telephone numbers for both individual subscribers (including collective use telephones) and departments, organizations, and enterprises. The telephone operator who functions as a computer operator formulates the request for the automated system in an interactive mode based on raw data provided by the caller and then provides a response to the subscriber after receiving the answer from the system. The average response time from the automated director assistance service is 2 sec. For commercial numbers a code system is used to access individual departments and public services. The system employs an SM1600 (primary and back-up) computer with an on-line memory capacity of 124,000 words. Six displays are connected to this computer. The software can perform such functions as database generation, modification, expansion, or elimination of data; request handling; database reorganization and printout of any section of telephone records of facilities in a form suitable for offset printing.

**A Universal RF Junction Set**

18600135b Moscow VESTNIK SVYAZI in Russian  
No 1, Jan 89 pp 44-45

[Article by R. G. Fuks, I. I. Sokol]

[Abstract] This article reports the development of an RF junction set for alignment and tuning of radio relay equipment. This junction set was developed by the Special Design Bureau of the USSR Ministry of Communications and consists of the most commonly utilized junctions and several other adapters and devices necessary for alignment and tuning operations in the construction of radio relay links. It will be manufactured in four configurations differing only in equipment complement. The set also includes a matched load to an "Ekspertiza"-type two-pin plug, a highly-sensitive detector section, a matched detector section that can also be used as a mixer and a matching attenuator. In order to improve wear resistance the junction housings were fabricated from 12X18H10T stainless steel.

### Atmospheric Humidity Tester

18600135c Moscow VESTNIK SVYAZI in Russian  
No 1, Jan 89 pp 46-47

[Article by V. I. Geets, A. T. Didenko]

[Abstract] This article reports the development of an atmospheric humidity tester for testing the relative humidity of air in communications cables. The unit functions as an electrolytic sensor. Electrolytic sensors normally consist of two electrodes separated by a substance impregnated with an electrolyte. The electrolyte absorbs moisture from the surrounding gas and alters its concentration and, thereby, the electrical conductivity. The sensor is placed in a sealed housing which has inlet and outlet ports for connection to a pneumatic system and sealed contacts to which the sensor electrodes are connected. An electronic device is then connected to the sensors and when a specific threshold resistance between the sensor electrodes is reached (caused by the elevated water level contributed to the electrolyte from the air) a high humidity signal is generated.

### A Modulator for the SRV-5 Transmitter Based on the 140UD6 Integrated Circuit

18620146a Moscow VESTNIK SVYAZI in Russian  
No 2, Feb 89 pp 46-47

[Article by I. A. Anderson]

[Abstract] This article reports the development of a modulator for the SRV-5 transmitter that employs the 140UD6 integrated circuit as a preamplifier-limiter. The final stage of the modulator employs a push-pull four-transistor design with transistors VT1 and VT2 forming a phase inversion stage while the two power transistors VT3 and VT4 are used in the output stage. The supply and bias voltages of the 140UD6 operational amplifier are stabilized by a parametric voltage stabilizer. Extensive d.c. feedback through a resistor is used to maintain operational stability of the amplifier. The modulator is manufactured on a 220 by 150 mm printed circuit board and is installed in place of the AU6 modulator. No transmitter circuit or design changes are required in this modification.

### What Test Instruments are Mandatory?

18620146b Moscow VESTNIK SVYAZI in Russian  
No 2, Feb 89 pp 56-58

[Article by M. A. Yasinnik]

[Abstract] This article discusses the shortage of modern, functional and reliable test instruments and measurement equipment in the Soviet telecommunications industry. The article cites several examples of multigenerational foreign test equipment with continuously modernized component bases, updated specifications and design, etc. compared to the Soviet practice of long-term manufacturing of a single, outdated design. The author notes that the Tesla Corporation updates its electronic

meter designs every 5-7 years and that the primary meter manufactured by this company has gone through five modifications over a 20 year period, while over the same 20 year period Soviet domestic industry continues to manufacture the IUU-300 whose specifications are inferior even to the first modification of the Tesla meter. Other instrumentation discussed in this article includes trouble-shooting and fault localization instruments for use on cable communications lines. It is determined that replacement of the IP-7 measurement set with the IP-8 set is not always cost effective in all applications. The article also discusses the lack of special measurement instruments designed to account for the specific nature of communications equipment operation. An integrated test instrument specially-designed for communications equipment for both field and standard operating conditions is recommended. This unit should be manufactured in a compact design up to 1 kg in weight in a shock-resistant housing with a belt clip and be suitable for conducting electrical measurements on communications equipment. Finally, the article discusses the current shortage of suitable gas and methane detection and test equipment for use in communications facilities and discusses possible measures for redressing these problems.

### Attenuation Measurements in the Laying and Assembly of Optical Cables

18600185a Moscow VESTNIK SVYAZI in Russian  
No 4, Apr 89 pp 32-33

[Article by V. A. Shavlovskiy, A. I. Dyadyuk, S. N. Khotyaintsev, V. A. Svirid, L. K. Yarovoy, T. L. Andrushko]

[Abstract] This article describes a method of measuring optical fiber attenuation used by the specialists of the "Ukrsvyazstroy" Industrial Construction and Installation Union; this method employs a special optical matching device developed at the Kiev Polytechnic Institute. This optical matching device can be used to measure the attenuation of optical fibers by the break-in method. The matching device consists of the following components in series: a standard optical coupler connected to the output terminal of the tester, a section of a reference optical fiber, a standard connector, a microobjective aligned by a connector, a terminal connector, and a cladding mode extractor. The reference optical fiber segment which functions as a mode mixer is fabricated as several overlapping GRIN and step-refractive index optical fibers between .5 and .7 m in length. The article describes in detail the various measurement schemes for attenuation measurement in optical cables using this matching device together with the various appropriate testers for different optical cable lengths. One special feature of the method is that it can be used to determine the average attenuation for two opposite radiation propagation directions. An experimental test has revealed that when the test optical fiber meets the technical specifications the optical signal attenuation in opposite directions will be virtually identical.

**Packet Communications: the AX.25 Protocol***18600190a Moscow RADIO in Russian  
No 3, Mar 89 pp 10-13*

[Article by Ye. Labutin]

[Abstract] This article discusses the design, bit configuration and applications of the AX.25 swapping protocol specially developed for amateur radio operations. The swapping protocols contain seven levels. All RF operational logic is described on the second level. The AX.25 swapping protocol is a multipole, equal-access swapping protocol. In packet communications messages are transmitted in blocks—frames—and in addition to the information the frame will contain data on the frame purpose, sender, receiver, and repeater addresses used for routing of the messages together with a check sum used to verify the received frames. The article discusses the frame format: each completed set of information is called a frame and has its own format. Each frame begins with a unique sequence of bits which is called the flag and makes it possible to recognize the beginning of the frame. This is followed by the address field ranging from 14 to 70 bytes, the control field which is a single byte and the information field which ranges from 0 to 256 bytes with the check field equal to 2 bytes. An auxiliary identification field is generated when using the third, network, level; this level is part of the information field. Each frame also ends with a flag.

**New Developments in Cable Installation Technology***18600192a AVTOMATIKA I TELETEKHNIKA  
in Russian No 3, Mar 89 pp 20-22*

[Article by D. A. Popov]

[Abstract] This article is the second of two articles devoted to new techniques in cable installation. The present article proposes measures for cable installation that account for recommendations contained in the Instructions on the Evaluation of the Corrosion State of Lead Cable Jacketing on Existing Communications Lines. An inspection program was drafted for determining the corrosion state of cables which included a visual inspection of the protection coatings, couplings, and jacketings, resistivity measurements of soils along the route, measurements of the armor and jacketing potentials, selection and analysis of soil samples, and analysis of the corrosion activity of soils on steel, lead, and aluminum. The article draws certain conclusions based on extensive analysis of the installation conditions, armoring, and protective sheathing as well as the soil conditions for cable installation. The primary cause of sheathing (coupling) corrosion in cables during operation is penetration of soil electrolytes under the coupling flanges, as well as differences in the armor-sheathing and sheathing-lead coupling potentials. The

article proposes employing heat shrinking tubes to protect lead (aluminum) couplings during the installation process and to use protective coverings on armored cables.

**Digital Code and Phase Meter***18600192b AVTOMATIKA I TELETEKHNIKA  
in Russian No 3, Mar 89 pp 24-26*

[Article by V. I. Sokolov]

[Abstract] This article reports the development of a digital numerical code and phase meter for use on railroad lines. Working documentation has been drawn up for the digital code and phase meter while certain prototypes have been developed. These prototypes are presently under performance testing. This digital numerical code and phase meter can be used to measure the duration of any code signal element at various points along a rail circuit accurate to plus or minus 0.01 seconds for signal voltages of 0.1 to 250 V as well as the duration of any code element at relay contacts or a transmitter with a discrete accuracy of plus or minus 0.005 seconds together with the voltage of a code or continuous signal within a 0.1-250 V range accurate to 5 percent, locomotive signalling currents in the 0.1-100 A range and the shift angle between voltages on local and route windings of self-propelled diesel chassis relays accurate to plus or minus 1°. The digital code and phase meter includes an envelope detector, a balanced modulator, a bandpass filter, a voltage divider and a phase shifter. Signal traces through the unit are given together with block diagrams of the meter and its component parts. The meter is constructed on four printed circuit boards in a 255 by 140 by 180 mm housing. 134 and 140 series integrated circuits are used in the circuitry. The unit operators off an ordinary 220 V commercial power line.

**The Past and Future of Railroad Switchpoint Motors and Electric Drives***18600192c AVTOMATIKA I TELETEKHNIKA  
in Russian No 3, Mar 89 pp 27-28*

[Article by G. V. Pakin]

[Abstract] This article is a collection of personal observations and comments from an electrical engineer/technician on the Caucasus's section of the Northern Caucasus Railroad. The author notes that electric motors of 1950-1960 vintage are currently in use on the Northern Caucasus Railroad. Such motors meet all current operating requirements and the author questions subsequent efforts of the factory to simplify the technology by eliminating resin in the insulation and using the insulation bands alone. Multiple drive failures occurred after this change in policy. The author cites many different examples where changes in factory manufacturing processes as approved by the corresponding ministry organizations have had to be modified by field engineers to prevent massive failures or breakdowns of



electric drives and electric motors on railroad switch-points. The primary issues concern fastening versus soldering, improper mounting or assembly, brush jamming against the collector in electric motors, etc. The author's main line of argument is that many supposed improvements in manufacturing techniques and designs in fact create substantial additional difficulties for field engineers and technicians charged with the installation, operation and maintenance of electric drives and motors in the railroad industry.

### Noise Immunity and Efficiency of a Digital Cellular Radio Telephone

18600194d *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 22-26

[Article by L. Ye. Varakin]

[Abstract] This article demonstrates the high noise immunity and efficiency of a digital cellular radio telephone employing various channel division multiplexing techniques and using pseudonoise signals as well as correcting coding. The analysis considers time-division, frequency-division, and code channel multiplexing for pseudonoise signals, multicharacter and ideal coding. Such properties as the frequency efficiency and noise immunity of cellular mobile radio communications systems are analyzed. The specific digital coding techniques and performance characteristics of specific pulse-code modulation systems are examined, including those of the IKM-64 and IKM-32 systems. The potential characteristics of a cellular mobile radio communications system employing ideal coding are discussed. The effect of multipath propagation on the performance of such a system is also considered. It is determined that a digital cellular radio telephone with optimally-selected multicharacter coding parameters has excellent frequency efficiency. Quadrature biorthogonal coding represents a near-optimum coding technique for cellular mobile radio communications systems. Multipath propagation of radiowaves limits data transmission speed to a level of 1.5 Mbits per second.

### Estimate of Mutual Suppression of Overlapping Pseudonoise Signals in a Digital Matched Filter

18600194e *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 40-41

[Article by N. I. Bolshakov]

[Abstract] This article calculates the distribution and the distribution moments of a compressed pseudonoise signal in the presence of another pseudonoise signal. The sample calculation is carried out for the case of the compression of two pseudonoise signals with identical seven-element Barker codes overlapping in six elements for binary quantization of the input process. The article provides plots of the initial phase of the pseudonoise signal as well as the amplitude and initial phase relations of the two pseudonoise signals for a second initial moment at the output of the square-law generator. Calculations reveal that the degree of suppression is highly dependent on the initial phase and the ratio of these phases. Suppression is absent when the vectors of the pseudonoise signals have projections in different quadrature channels only. This method of calculating the distributions and their moments allows determination of the suppression levels for more than two interfering pseudonoise signals and a random number of quantization thresholds and distribution laws accounting for the randomness of the signal parameters, transient processes and pseudonoise signal suppression due to the action of an interfering pseudonoise signal with a different element coding technique and under pulsed and monochromatic interference.

### Robust Processing of a Pseudonoise Signal in an $\epsilon$ -Contaminated Channel

18600194f *RADIOTEKHNIKA in Russian*  
No 3, Mar 89 pp 52-53

[Article by D. G. Kozlov]

[Abstract] This article develops a robust processing algorithm for a pseudonoise signal in an  $\epsilon$ -contaminated channel. The study employs deaming theory to derive formulae which indicate that even in the absence of a priori knowledge of the initial "uncontaminated" probability distribution density it is possible to formulate a robust signal processing algorithm for a pseudonoise signal in an  $\epsilon$ -contaminated channel. In this case the guaranteed losses of the device under design are much less than those of a limiter-correlator.

UDC 621.382

**Kinetics of Processes During Etching of Nitrocellulose Films by Intermediate-Energy Ions and by Infrared Radiation***18600233a Moscow MIKROELEKTRONIKA in Russian Vol 18 No 3, May-Jun 89 pp 215-220*

[Article by Ye. A. Bogdanova, K. A. Valiyev, A. G. Lyubimov, A. V. Rakov, I. V. Strizhkov, and A. G. Shchuchkin, Institute of General Physics, USSR Academy of Sciences]

[Abstract] An experimental study of nitrocellulose films etched by infrared radiation and by ion beams was made, of interest being the kinetics of these etching processes and the attendant molecular restructuring. Films with nitrogen constituting 12.3 percent of the molecular mass in the monomer link were grown to 0.0003-0.0025 mm thickness on bilaterally polished KDB-10 silicon wafers from a solution of nitrocellulose in amyl acetate in a centrifuge, then dried in air at room temperature. The film thickness was regulated by varying the centrifuge speed and was monitored with an MII-4 microinterferometer. A thin aluminum coating eliminated the phase shift due to reflection of light by the different materials. Infrared absorption spectra were recorded in "Specord M-75" and "Specord M-80" spectrometers. For ion bombardment were used beams of 100 keV  $^{11}\text{B}^{+}$  ions with a current density of 100-200 nA/cm<sup>2</sup>, X-ray photoelectron spectra of initial films as well as of films with bombardment with 0.010 mC/cm<sup>2</sup> and with 0.150 mC/cm<sup>2</sup> being recorded in an "Escalab MK-11" instrument with 1486 eV AlK<sub>α</sub> radiation and 1254 eV MgK<sub>α</sub> radiation. The results indicate what changes occur in nitrocellulose films upon etching by these two methods. Figures 3; tables 1; references 4: Western (1 in Russian translation).

UDC 621.382

**Theoretical Study of Pattern Transmission Through Stencil Templates by Corpuscular Radiation***18600233b Moscow MIKROELEKTRONIKA in Russian Vol 18 No 3, May-Jun 89 pp 221-230*

[Article by K. A. Valiyev, A. N. Kirillov, T. M. Makhviladze, and M. M. Mkrtchyan, Institute of General Physics, USSR Academy of Sciences]

[Abstract] Transmission of patterns through stencil templates by wide beams of charged particles is considered, for circuit microstructurization, and a method of analytically calculating the transfer function is outlined, computer-aided statistical simulation of particle trajectories by the Monte Carlo method being too cumbersome. The transfer function, which characterizes the dependence of the illuminance distribution over the object surface on the angular divergence of the particle beam and on the distance from object to template as well as on the dimensions of open and shadow template segments, is calculated

assuming that a template of finite thickness can be replaced with an infinitesimally thin diaphragm impervious to charged particles within its shadow regions. First is considered the one-dimensional problem of a zero-thickness template with a single window in the form of an infinitely long straight slit. This slit is then replaced with a rectangular one so that the problem becomes a two-dimensional one. The calculation method is readily extended for templates of any regular or irregular structure. The performance of such a projector is, on this basis, evaluated in terms of pattern image parameters. The design of such a projector can, moreover, be optimized for a maximum transmission coefficient with minimum amplitude of particle-beam intensity fluctuations. Figures 5; references 4: 3 Russian, 1 Western.

UDC 621.382

**Use of MTIS-Diodes in Charge-Coupled Devices***18600233c Moscow MIKROELEKTRONIKA in Russian Vol 18 No 3, May-Jun 89 pp 256-259*

[Article by V. V. Rakitin, A. G. Safonov, V. V. Tarasenko, V. I. Khaynovskiy, and A. V. Serebrennikov]

[Abstract] Use of MTIS-diode structures in charge-coupled devices is examined, a typical such device being a register with a charge lead-in diode on the input side and an MOS-transistor source follower on the output side. The tunnel-thin dielectric interlayer between the metal electrode (gate) and the semiconductor (Si) substrate partially replacing the thicker insulation interlayer makes a perfect interface, because the density of surface states is low and consequently shielding of the implanted charge is negligible. It therefore becomes possible to attain strong inversion for a change of the conductivity type at the semiconductor-dielectric boundary by selection of the electrode metal and to vary the magnitude of the conductivity by control of the semiconductor doping level. Strong inversion from p to n conductivity and from n to p conductivity can occur only when  $W_s - W_m - 2(E_f - E_i)$  for p-Si and  $W_m - W_s - 2(E_f - E_i)$  for n-Si are larger than the voltage across the tunnel-thin dielectric interlayer ( $W_s$  - work function of semiconductor surface,  $W_m$  - work function of metal surface,  $E_f$  - Fermi energy of doped semiconductor,  $E_i$  - Fermi energy of intrinsic semiconductor, voltage across dielectric interlayer equal to negative or positive implanted charge plus surface charge divided by capacitance). An experimental study has confirmed that the technology of MTIS-diodes is compatible with miniaturization and integration of charge-coupled devices, while their electrical performance including current-voltage characteristic and voltage transfer ratio are quite adequate for this application. It was not feasible to increase the density of the tunnel current above 10<sup>3</sup> A/cm<sup>2</sup> by decreasing the interlayer thickness below 1.5 nm. The authors thank L. V. Krutikova for assisting with fabrication of experimental devices. Figures 3; references 5: 2 Russian, 3 Western (2 in Russian translation).

**Selection of Outdoor Electrical Equipment Screens  
for High Frequency Operating Conditions**

18600187c *ELEKTRICHESTVO in Russian*  
No 3, Mar 89 pp 59-63

[Article by V. P. Larionov, T. N. Tarasova]

[Abstract] This article discusses the various factors that influence the selection of screens employed to shield high-power outdoor power equipment from such environmental factors as rain, wind, snowfall, hail, etc. The danger of corona discharge for high-voltage power plants

is discussed. Special attention is devoted to rain-induced coronal discharge. Plots of the corona initiation voltages as a function of protective pipe radius are provided. The study carries out experiments to determine the conditions of rain-induced unstable coronal discharges. The experimental analyses made it possible to establish a phenomenology behind the conversion of unstable coronal discharge produced by water droplets into stable coronal discharge on an electrode and to explain this process. Conditions are also proposed for selecting screens.

**High Power Noncontact Inductor-Type d.c. Converter***18600189a PROMYSHLENNAYA ENERGETIKA  
in Russian No 3, Mar 89 pp 23-24*

[Article by A. M. Plakhtiev]

[Abstract] This article reports the development of an inductor-type noncontact converter at the Tashkent Polytechnique Institute. The converter consists of an inductor-type noncontact d.c. transducer and an analog-digital section together with a meter. The transducer contains a detachable magnetic circuit fabricated from separate ferromagnetic elements with intervening gaps. The elements have holes through which the sections of the modulation winding are wound; these coils are in series and are connected to a stable a.c. power supply. The specifications of this unit are as follows: d.c. current range, kA: 0-10; bipolar output voltage, V: 0-24; error, percent: 1.5; delay, mcs: 1.7; supply voltage, V: 220; power consumption, V.A: 33. The high power noncontact inductor-type d.c. converter is simple to manufacture, easy to operate and functionally reliable.

**The "Sila-2" Computer-Aided Design System for Electrical Power Equipment***18600189b PROMYSHLENNAYA ENERGETIKA  
in Russian No 3, Mar 89 pp 31-32*

[Article by S. A. Fridman, P. P. Nikushenko, Ya. B. Simanovskiy]

[Abstract] This article reports the development of the "Sila-2" computer aided design system for electrical power equipment. This system produces standards and documentation for electrical power equipment, including 380 and 660 V a.c. networks; power, test, and combined networks; zones of any type; power lines (less than 1000); power distribution circuits (radial, trunk and combined circuits); power distribution devices; current conducting lines; primary and reserve lines, and support structures. The system includes the following primary components: software of modular design with a control program and the capability for real-time selection of the computer-aided design trajectory; software based on the "Sprut" database management system employing two data bases: one documentation data base for data retrieval and one data base containing current data on the site or installation under design. The system also includes hardware with the following minimum equipment complement: a YeS computer with a minimum 512 kbyte RAM, a punched card input device, an alphanumeric printer, three magnetic tape storage units, and a plotter.

UDC 622.311

**Operating Modes and Stability of Power System Including 1150 kV Overhead Transmission Line***18600203a Moscow ELEKTRICHESKIY STANTSII  
in Russian No 4, Apr 89 pp 46-51*

[Article by D. L. Balyberdin, engineer, T. A. Gushchina, engineer, L. A. Koshcheyev, candidate of technical sciences, and V. A. Shlayfshteyn, candidate of technical sciences, Scientific Research Institute of Direct Current]

[Abstract] The process of starting up a long 1150 kV overhead transmission line is analyzed, the transfer from a 500 kV line being effected sectionally with the aid of adjustable kvar compensators. The effect of such a start-up on the capacity of the transmission line and on the stability of the entire power system is evaluated by the simulation method, the electrodynamic model being reduced to three equivalent generators interconnected by the new 1150 kV line and also by the existing 500 kV line parallel to the latter. The 1150 kV line is thus subdivided into three segments with a group of switchable 900 MVA shunt reactors at each node for start-up. For full operation are installed one inductive 0-1000 MVA thyristor-type static compensator at two nodes and four 320 MVA synchronous compensators at the third node. The capacity of the transmission line is enhanced by insertion of automatic excitation and voltage regulators. Compensators with discrete regulation including a 200-300 MVA step can replace compensators with continuous regulation without lowering the natural stability limits, static and dynamic, of the power system. The dynamic stability under short circuits on the transmission line is evaluated, for the design of single-phase automatic reclosure. Figures 5; reference 1: Russian.

UDC 621.314.222.6-762.001.4

**Test Results on Hermetically Enclosed Transformers and Results of Their Trial Operation***18600203b Moscow ELEKTRICHESKIY STANTSII  
in Russian No 4, Apr 89 pp 52-55*

[Article by S. S. Kustov, engineer, All-Union Scientific Research Institute of Electrical Power Engineering]

[Abstract] A lot of 15 hermetically enclosed 400 kVA and 160 kVA distribution transformers, a new series produced at the Minsk Electrical Equipment Manufacturing Plant, was tested in trial operation for a period of 3 years. Transformers of the TMG/TMVG 400/10 class were operating in urban networks (Bobruysk, Mogilev) in coordinated substations. Transformers of the TMG 160/10 class were operating in rural networks (Timash-evsk/Krasnodar, Slobodskoy/Kirov) in indoor substations. They were tested for temperature rise in summer and in winter, by the short-circuit method, and for the acid number of oil. Their tanks, welded structures with fins, were tested for mechanical strength under cyclically



varied gage pressure by both oil leakage and water leakage methods. The results of the trial operation were, on the basis of these tests, satisfactory. Figures 2; tables 4.

UDC 621.311.22.002.5.004.58:061.2

**All-Union Conference on Progress in Construction and Installation of Technical Diagnostic Testing Systems for Thermomechanical Equipment in Thermal Electric Power Plants**

18600203c Moscow ELEKTRICHESKIY STANTSII in Russian No 4, Apr 89 pp 86-88

[Article by A. Sh. Leyzerovich, doctor of technical sciences]

[Abstract] An All-Union conference on construction and installation of technical diagnostic testing methods and systems for thermomechanical equipment such as boilers and turbines in thermal electric power plants was held during the November 1988 Kiev Exhibition of Achievements in the USSR National Economy, this conference having been organized jointly by both USSR and UkSSR Ministries of Energy together with the All-Union Institute of Heat Engineering imeni F. E. Dzerzhinsky. The problems in implementing this program and progress already made were reported in over 50 presentations and broadly tackled in ensuing discussions. Recommendations were formulated for the agenda of the next conference to be held by the Coordination Council on Technical Diagnostic Testing of Power Equipment, at the USSR Ministry of Energy, and the UkSSR Ministry of Energy was asked for information about the already working Remikont operational control of 300 MW turbine runners. A request was also made that the Kiev Polytechnic Institute cooperate in obtaining a process computer for technical diagnostic testing of boilers and turbines.

UDC 621.317.016.38

**Calculation of Pulse Interference in Secondary Circuits of High-Voltage Substations**

18600209a Moscow ELEKTRICHESTVO in Russian No 4, Apr 89 pp 23-32

[Article by V. I. Glushko, candidate of technical sciences, Belorussian Department, All-Union State Design Institute and Scientific Research Institute 'Power Network Design']

[Abstract] A simple method of calculating the interference level in secondary circuits of high-voltage substations is proposed, considering that protective relaying and automation devices built with microelectronic components are dangerously sensitive to pulsed electromagnetic fields from natural or man-made interference sources. The interference source is characterized by a given busbar current in the case of lightning or switching overvoltages and by a given electric field intensity in the case of an incident external wave. A primary circuit is

regarded as a single-conductor line, superposition of phase fields being applicable when all phases need to be considered. Secondary circuits are assumed to consist of underground or surface cables, unshielded or shielded, with electrical conductivity and magnetic permeability as characteristic parameters. The general problem reduces to calculation of induced voltages and currents in a multiconductor secondary circuit, the solution being simplified by replacement of the cable sheath and armor with an equivalent tubular shield. The influence of secondary circuits on primary ones and the influence of conductor on shield are disregarded, a conductor being assumed to be under no load and not to be influenced by other conductors. A secondary circuit is accordingly treated as a lossless transmission line. The particular solution to the corresponding system of two second-degree differential equations for voltage and current, as functions of the longitudinal space coordinate and the Carson transform parameter, yields a convolution integral for the induced voltage. Particular solutions are obtained for an unshielded cable grounded only at the locations of protective apparatus in the common control post or of measuring instruments in the open distributor post, for an unshielded cable grounded through a capacitance, and for a shielded cable with the shield grounded at both common control and open distributor ends. The protective action of relaying and automation apparatus, in terms of lowering the interference level, is evaluated on the basis of this analysis. Figures 3; references 8: 6 Russian, 2 Western (in Russian translation).

UDC 621.316.761.2.016.2.001.2

**Inductive Energy Storage in Kvar Source**

18600209b Moscow ELEKTRICHESTVO in Russian No 4, Apr 89 pp 58-62

[Article by I. V. Belousov, candidate of technical sciences, and S. G. Sokolov, candidate of technical sciences]

[Abstract] Performance and design of reversible static kvar compensators with low-capacity inductive storage are analyzed, such a device consisting of a multi-bridge current inverter with silicon controlled rectifiers across an electromagnet on the input side and across a transformer on the output side. Direct current flows through the electromagnet coil and the inverter bridges. In an inverter with N bridges in series the control angle is  $60/N$  deg larger for each successive rectifier. After establishment of the basic voltage and current relations, assuming that the rectifiers are switched instantaneously and that a sinusoidal current flows in the transformer primary, all currents are plotted on the time scale and the power phasor diagram is constructed for a compensator operating in the basic mode. The total power pickup and throw-off time, which characterizes the compensator speed, does not exceed one period of a 50 Hz current. The harmonic content in the output current decreases appreciably as the number of bridges is increased, already an inverter with 4-6 bridges not requiring a filter

for suppression of the fifth and higher harmonics. The compensator design is subsequently optimized for maximum utilization with energy storage, d.c. operation being preferable to a.c. operation with an inverter consisting of three or more bridges when the ratio of maximum to minimum direct current and thus the kvar regulation ratio are 100. On this basis has been designed a 20 MVA compensator with four inverter bridges and a 0.2 H—650 A inductive energy storage for tapping into a 110 kV network through a 6/110 kV transformer. Figures 4; tables 1; references 4: Western.

UDC 621.311:614.825:519.5.001.57

### **Estimation of Electrical Safety According to Theory of Fuzzy Sets**

18600209c Moscow ELEKTRICHESTVO in Russian  
No 4, Apr 89 pp 62-66

[Article by T. G. Pospelova, candidate of technical sciences, Belorussian Polytechnic Institute]

[Abstract] Electrical safety in the environment of a controllable electrical power object is analyzed and estimated, using the apparatus of fuzzy sets rather than probability statistics. All possible are, with respect to safety, grouped into four classes:  $A_1$ - safe,  $A_2$ - slightly dangerous,  $A_3$ - dangerous,  $A_4$ - very dangerous. External and internal perturbations affecting the state of the system are considered. The membership function of technical states is, for the purpose of quantitative estimation, selected as measure of the safety level and its indicators. The algorithm of such an estimation is formulated in three steps, the first step being determination of particular membership functions for the system components by transition from point values. The second step of forming generalized membership functions for the aggregate state of the entire system is followed by determining the membership for the complete state of the entire system as composite indicator of its electrical safety. The apparatus of fuzzy sets is most consistent with the mechanism and the structure of electrically dangerous situations. It also yields most adequate mathematical models for their identification and prevention. References 9: Russian.

UDC 621.311.021

### **Stepwise Correction of Afterfault Operating Modes in Electric Power Systems**

18600210a Moscow IZVESTIYA AKADEMII NAUK  
SSSR: ENERGETIKA I TRANSPORT in Russian  
No 2, Mar-Apr 89 pp 34-40

[Article by P. I. Bartolomey, N. I. Grudinin, and A. A. Yaroslavtsev, Sverdlovsk]

[Abstract] Recovery of an electric power system after a fault by action of protective automatic control with stepwise correction is considered, the basic problem being reentry into the allowable range of operating modes as defined by a set of constraints on voltage levels, currents, and power. The solution to this problem is a vector of control actions, the next problem being to devise a strategy of safe control which will ensure that any trajectory from the initial afterfault state to the normal new state remain within the range of allowable intermediate afterfault modes so that constraints will not be violated owing to sluggishness of the control system and to lack of coordination between control actions in the various plants of the power system. The concept of lower control boundary, an  $m$ -dimensional boundary of an  $n$ -dimensional control hypercube, is introduced and the simplex of admissible controls is constructed for first determining the range of safe control actions and then devising a control strategy with the minimum number of corrections in each power plant. The lower control boundary and the simplex of admissible controls are also being involved for selecting the sequence of control actions which corresponds to the optimum trajectory within a control cycle, namely the trajectory with the minimum number of correction steps and thus requiring the minimum amount of time. Figures 2; tables 1; references 3: 1 Russian, 2 Western.

UDC 621.311

### **Improving Controllability of Unified USSR Electric Power System by Use of D.C. Insert and Lines**

18600210b Moscow IZVESTIYA AKADEMII NAUK  
SSSR: ENERGETIKA I TRANSPORT in Russian  
No 2, Mar-Apr 89 pp 48-54

[Article by Yu. V. Shcherbina, Kiev]

[Abstract] The trend toward use of direct current for transmission of electric power and its implications for the Regional and Integrated Electric Power Systems are discussed, with emphasis on improvement of the system controllability. The main problems are seen to be compatibility of d.c. lines or inserts with a.c. power generating apparatus and their sufficiency as interconnecting components, namely whether an a.c. line in parallel with a d.c. line is required for ensuring precise synchronization or whether the synchronization requirements may be relaxed. These problems as well as those of reliability, viability, and economy need to be tackled theoretically before practical solutions can be arrived at for an adequate main network of the Unified USSR Electric Power System scheduled to become operational during the 2010-15 five-year period. References 20: Russian.

UDC 621.316.925:518.4.001.24

### Sensitivity of Protective Distance Relays

18600210c Moscow IZVESTIYA AKADEMII NAUK  
SSSR: ENERGETIKA I TRANSPORT in Russian  
No 2, Mar-Apr 89 pp 73-80

[Article by S. M. Moiseyev and A. I. Malin, Novosibirsk]

[Abstract] The sensitivity of a protective distance relay is evaluated on a probabilistic basis, assuming an otherwise ideally reliable and selective relay with stable response speed. The probability of relay action in the case of faults within the protected system segment or the minimum probability of relay action in the case of a most heavily demanding short circuit behind the protected system segment are shown to be more objective and less ambiguous indicators of sensitivity, a nearly normalizable one, than the conventional normalizable minimum sensitivity. The sensitivity is accordingly calculated, along with the minimum probability of relay action in the case of most heavily demanding short circuit, on the basis of simulation experiments involving second and third steps of distance relaying with an ideal circular impedance diagram and with a more real elliptical one. The network model is one with bilateral feed, with a distance relay in one of the two substations, and with one of the two conductors grounded through a transformer. These experiments yield a regression equation for the normalized sensitivity, with one free term and with five coefficients which appear alone or as products of two in the other eight terms and represent five influencing factors: circuit-breaker arc resistance, line resistance, voltage phase shift across arc, impedance modulus and angle seen by relay. Errors of potential and current instrument

transformers are taken into account on the basis of appropriate simulation. Figures 3; tables 1; references 12: Russian.

UDC 621.311.17.316.92.001.2

### Automatic Protection of Electric Power Plants Against Consequences of Heavy Faults

18600210e Moscow IZVESTIYA AKADEMII NAUK  
SSSR: ENERGETIKA I TRANSPORT in Russian  
No 2, Mar-Apr 89 pp 149-154

[Article by M. Ya. Kleisel and I. N. Solodukhin, Pavlodar]

[Abstract] Automatic prevention of total loss of power for electric power plant auxiliaries is proposed, total loss of power mostly likely occurring as a consequence of heavy faults such as a short circuit in the high-voltage distribution network with attendant failure of protective relays or circuit breakers. The gist is controlling the overload on the standby starter transformer by automatically disconnecting from it as many motors as necessary, two possible schemes being considered for this. In the first one the overload is monitored indirectly by counting the number of plant-auxiliary section circuit breakers connected to the standby power busbar and loss of power is indicated by tripping of the relays for motors of a section of plant auxiliaries. In the second scheme the overload is monitored by measuring the transformer current and loss of power is indicated by the current dropping to zero. The algorithms and the logic diagram for each scheme are outlined, whereupon their circuit structures with provision for self-restarting of motors are synthesized. A comparative evaluation of the two schemes gives some preference to the first one, on account of its simpler circuit structure. Both schemes are suitable for computer-aided automation. Figures 4; references 3: Russian.

UDC 621.315.615.001.5

**Dielectric Impregnating Compounds for Power Capacitors***18600235b Moscow ELEKTROTEKHNIKA in Russian No 5, May 89 pp 47-51*

[Article by I. F. Pereselentsev, candidate of technical sciences, Ye. L. Ginzburg, engineer, and Yu. I. Stupin, engineer, All-Union Scientific Research Institute of Synthetic Rubber]

[Abstract] Seven liquid dielectric impregnating compounds for high-voltage film-paper capacitors are comparatively evaluated with respect to gas absorption, dissolution, and evolution during a.c. partial discharge as well as with respect to electrophysical and thermophysical characteristics, considering the adverse ecological impact of chlorodiphenyls now used. The evaluation

is based on gas-tightness tests with a Pirelli instrument, in air and under vacuum, in a 50 Hz a.c. electric field of 7 kV/mm intensity. The data have been processed and interpreted according to applicable theory of discharge and gas kinetics, in terms of pressure and partial-discharge field intensity as functions of time. The results indicate that compounds based on aromatic rings without lateral chains (trichlorodiphenyl, phenyl xylyl ethane, S101 "hot mold") are superior to compounds based on aromatic rings with lateral chains (dioctyl phthalate, benzyl neocaprinate) and to aliphatic compounds (petroleum extract, castor oil) in terms of resistance to partial discharge. Stabilization of trichlorodiphenyl with an additive such as epoxy was found to improve its loss tangent at 20-100 deg C temperatures and may be preferable to replacement with a compound whose some other characteristics are worse. Figures 4; tables 1.



### Electromagnetic Field Calculations in Regions with a Free Boundary

18600187b ELEKTRICHESTVO in Russian  
No 3, Mar 89 pp 40-45

[Article by E. L. Amronin, G. N. Kaporskaya, A. B. Novgorodtsev, S. L. Shishigin, G. A. Shneerson]

[Abstract] This study considers sample electromagnetic field calculations in areas with a free boundary. In these calculations the free boundary represents a portion of the border of the calculated region or the interface of the regions whose shape is unknown in the formulation of the problem and is subject to definition during the solution based on conditions imposed on the boundary. All calculations carried out in this study in the quasistationary field approximation are reduced to a solution of the Laplace equation in a domain whose form is determined by the constant field strength condition imposed on the free section of the boundary. A sharp surface effect is assumed to exist in analyzing pulsed solenoids and equilibrium configurations of an ideally conducting liquid on their surface where the currents are characterized by a surface distribution and no normal field component exists on the conductor surface. The static problems are solved with traditional boundary conditions of given electrode potentials or magnetomotive forces which corresponds to an assumption of unlimited permittivity of the ferromagnetic. The article illustrates the application of various solution techniques by a sample calculation of the equilibrium configurations of an ideally-conducting liquid in a magnetic field of counter-running currents. An analytic solution is found in a plane-parallel approximation for a system of currents flowing through solid rectilinear conductors of quadrupole symmetry. The solution is simplified by analyzing the field in the central region of the system where the current-carrying conductors are of unlimited size. The study also provides calculation results for cross-sectional profiles of a solid single-winding solenoid as well as various electrode profiles and configurations.

UDC 620.179.14

### Magnetic Analyzer for Quality Control of Steel Products

18600201c Sverdlovsk DEFEKTOSKOPIYA in Russian  
No 3, Mar 89 pp 82-88

[Article by M. A. Melguy and S. G. Sandomirskiy, Institute of Applied Physics, BSSR Academy of Sciences]

[Abstract] A new magnetic analyzer MAKSI has been developed for quality control of steel and iron products, specifically for 100 pct in-process inspection of articles moving on a conveyor belt. It measures both maximum and residual magnetic flux, during and after magnetization respectively, as indicators of mechanical characteristics reflecting the quality of heat treatment and thus as criteria for acceptance or rejection. It consists of a guide

bar, a source of magnetizing current, two channels with a measuring coil in each, three compensating coils, a set of digital comparators, a pass-or-reject tester, a sorter, and a numeric printer. It excels existing magnetic analyzer not only in information yield and accuracy but also in productivity, being capable of testing up to 5 pcs/s continuously for up to 8 h. It draws a power of 160 W maximum and operates at temperatures of 5-40 deg C. The MAKSI received the Silver Medal at the 1987 Exhibition of Achievements in USSR National Economy. Its technical features have been patented abroad (CSSR, GDR, FRG, France, Italy). Figures 4; tables 1; references 13; Russian.

UDC 621.386.82(088.8)

### Dosimeter With Ionization Chamber Operating in Bipolar Mode

18600201d Sverdlovsk DEFEKTOSKOPIYA in Russian  
No 3, Mar 89 pp 89-91

[Article by V. G. Volkov and M. M. Shteyn, Scientific Research Institute of Introscopy, Tomsk]

[Abstract] A bremsstrahlung dosimeter has been built with an ionization chamber operating in the bipolar mode as detector. The ionization chamber with plane-parallel electrodes is, together with an integrating capacitor and a cathode follower, contained in a portable probe. Its operation in the bipolar mode simplifies detector-current-to-frequency conversion. Its active volume is 50 cm<sup>3</sup>. The integrating capacitor, which does not absorb radiation, operates in the recharge mode so that no compensation for drift of the potential in the input stage is required. The probe is connected through a 50 m long cord to a stationary recording set which includes a comparator, a voltage commutator consisting of two transistor switches and two photodiode optrons, a 3-position counter, and a light-emitting-diode indicator. The range of this dosimeter is 0.01-10 R/min. The supply voltage, not higher than 50 V for measuring an exposure dose of 10 R/min, is readily switched. The sensitivity of the probe is 10<sup>-8</sup> C/R. The instrument was tested in 4 MeV and 30 MeV betatrons, its reading being checked against those of a 27012 dosimeter (made in the GDR). Its error does not exceed 3 pct at 10 deg C, 12 pct at 40 deg C. Figures 1; references 5; Russian.

### A Niobium-Tin Superconducting Magnet System

18600255b ELEKTROTEKHNIKA in Russian  
No 6, Jun 89 pp 62-64

[Article by Ye. N. Andreyev, Ye. Yu. Klimenko, Ye. K. Koshurnikov, S. I. Nevikov, V. N. Shakhtarin, A. K. Shikov]

[Abstract] This article is devoted to a general discussion of the properties and performance of niobium-tin multifilament wire. Such wire is favorable for superconducting applications as it is suitable for operation at a high critical

temperature (17.8 K) and in high critical induction conditions (capable of operating at induction levels of 21-23 Teslas at 4.2 K) and has low loss levels in alternating fields. The article focuses on the use of niobium-tin wire in a superconducting magnet system, specifically, in the excitation windings of cryogenic turbogenerators. The primary

industrial manufacturing processes and designs for fabrication of low-temperature superconducting windings are discussed and test results on the windings are provided. The design of the overall magnet system and its component parts are given together with the functional parameters of the superconducting niobium-tin winding.

### Use of Pneumatic Devices in Mine Ventilation Systems

18620140a Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 11, Nov 88 pp 16-18

[Article by A. M. Kasimov, V. V. Kupriyanov]

[Abstract] This article is devoted to analysis of the application of pneumatic devices to dust removal/ventilation systems in underground mines. The pneumatic devices are controlled by an automatic regulation system that continually varies the flow rate of pressurized air by altering the level of the compensation signal and shifting the quiescent point to obtain the optimum conditions for minimum dust concentration in the mine environment. In the automatic system implementing the control method proposed here the air quantity is measured by means of two pneumatic air flow measurement systems. Secondary instruments in these systems continually monitor the ongoing supplied air and extracted air. The requisite level of extracted air containing toxic gases and dust is set by a control regulator. The regulator set is compensated by the dust measurement system as a function of dust concentration in the mine atmosphere. The regulator output signal controls the drive mechanism of the extraction fan and alters fan speed in accordance with the regulator operating point.

### Pressure Transducers Based on $Al_xGa_{1-x}As$

18620140b Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 11, Nov 88 pp 24-26

[Article by K. E. Bernotas, V. K. Koltakov, E. I. Kudryashov, G. P. Tautvayshas, A. A. Gritsyus, Ch. I. Shimkyavichyus, S. G. Zhilyonis]

[Abstract] This article reports results from research conducted at the Institute of Semiconductor Physics at the Academy of Sciences of the Lithuanian SSR devoted to the fabrication of "Varizon-1"-type fixed and variable pressure transducers which employ  $Al_xGa_{1-x}As$  solid solution crystals as the sensors. The sensors consist of a single crystal  $Al_xGa_{1-x}As$  layer grown by liquid phase epitaxy onto a gallium arsenide wafer which has a high electrical resistivity. Two metallic contact pads are vacuum-deposited onto the layer surface and wires are soldered to these pads for connecting the sensors to the electrical pins of the pressure transducer. A batch of sensors with similar properties was fabricated by growing  $Al_xGa_{1-x}As$  layers onto wafers 30-40 mm in diameter. Photolithography and selective etching techniques were used for cutting the sensors from the wafer. The sensors were 1 x 1 x 0.5 mm with a nominal resistance of 300 plus or minus 50 ohms. The "Varizon-1" sensors can be used in electrical machinery and equipment (compressors, motors, etc.) for monitoring the explosive treatment of materials and in other fields of the national economy where fixed and pulse pressure levels require measurement.

### Noncontact Position Sensors for Control Systems in Robotized Manufacturing

18620140c Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 11, Nov 88 pp 26-28

[Article by A. Ya. Ksenzenko, A. K. Legkobyat, V. A. Zotov, I. V. Izotova, V. A. Rolik, L. P. Shatskaya]

[Abstract] This article reports the development and mass manufacturing of a family of compact, noncontact optical and electromechanical position sensors at the "Spektr" ["Spectrum"] (Moscow) Scientific and Industrial Union; the sensitive range of these sensors ranges from hundreds of micrometers to tens of meters. The optical sensors have a common design consisting of a master oscillator producing control pulses of approximately 2 kHz in frequency and .5-2 mcs in duration. These pulses are amplified by an amplifier stage to approximately .5 amps and sent to a gallium arsenide light-emitting diode, where they are converted into light pulses. The resulting light signal is then guided to the control range. When an object falls within this range a portion of the luminous flux strikes the aperture of the optical system of the sensor receiver. After optical filtering the light signal is focused on the surface of the optical detector photodiode crystal where it is converted into electrical pulses that are then amplified by a low-noise amplifier. The optical sensor nomenclature includes the DOBTs-10 through DOBTs-16 units. The electromagnetic sensors are designed for noncontact position monitoring of components and parts manufactured from electrical conducting material relative to the support base of the machine and for high-precision position control over automatic manufacturing mechanisms. The principle of operation of these sensors is based on conversion of a mechanical parameter (distance) into an electrical signal by the vortex current method. The electromechanical sensor nomenclature includes the DOBTs-1 model through the DOBTs-4 model. The article discusses certain possible applications of these devices.

### Precision Displacement Transducer

18620140d Moscow PRIBORY I SISTEMY  
UPRAVLENIYA in Russian No 11, Nov 88, p 28

[Article by Sh. Yu. Ismailov, M. I. Reva, Ye. Yu. Trunov]

[Abstract] This article discusses a position displacement transducer that converts motion into a pulse repetition period; in order to overcome certain design difficulties this device employs a new method of generating and converting the information parameter of the inductosyn output signal. The transducer is an inductive parametric linear or angular displacement transducer converting displacement into a mutual inductance value between the first winding on one of the displaced transducer elements and the second and third windings located on the other element. The first winding of the transducer in this design is powered by short, high-amplitude pulses of

linearly increasing current and pulse repetition rate from the output of a linear voltage generator. After the initial state of the generator is set, switches in the unit are closed and the generator begins to produce sinusoidal oscillations. The transit points of the signal through zero are fixed by the comparator which produces square-wave pulses with an initial phase directly proportional to the displacement. These pulses are then sent to the complementary input of a flip-flop used to control the relative pulse duration of the supply pulses. The flip-flop returns the circuit to its initial state, i.e., the voltage oscillator is refired and the switches are closed for a period determined by the pulse duration at the output of the univibrator, etc. This is the design arrangement whereby pulses whose pulse repetition period is a linear function of the measured displacement are produced at the output of the univibrator.

### How to Prevent Corrosion

18600185b Moscow VESTNIK SVYAZI in Russian  
No 4, Apr 89 pp 41-43

[Article by A. I. Kudryashov]

[Abstract] This article discusses several causes of the increasing incidence of telephone cable corrosion in the

Moscow area, together with commonly-accepted methods and techniques for corrosion prevention. The article cites several factors contributing to the elevated level of electrochemical corrosion, including: higher levels of both commercial and domestic waste and pollution, the use of chemical agents for fighting ice deposits on underground lines and soil salinity. The sharp differential in ground water levels near heavily-used artesian wells has caused strong differentials in soil pressures on cable routes. This has produced organic corrosion sites on underground telephone cables in the Moscow area. The article also notes that the construction of protective structures to reduce corrosion has not in fact, reduced the number of corrosion incidents. The article proposes a comprehensive program for corrosion protection in the nationwide network in three stages. The first stage focuses on the long-distance telephone lines, coaxial cable lines, and domestic communications cables and covers only those areas where corrosion has already been identified. The second stage involves protection of regions with irregular voltage conditions caused by stray voltage. The third stage specifies protective measures for areas employing cables with protective jacketing unsuitable for protection against chemical corrosion for the case where chemical analyses have revealed corrosion defects.

UDC 621.372.833.1

**Wide-Aperture Focusing of Radiation in Excited Optical Waveguide by Means of Annular Grating**

18600063c Leningrad *ZHURNAL TEKHNIЧЕСКОY FIZIKI* in Russian Vol 58 No 8, Aug 88 pp 1628-1632

[Article by V. A. Kiselev and S. N. Shaposhnikov, Institute of General Physics, USSR Academy of Sciences, Moscow]

[Abstract] Replacement of a thick lens with a thin diffraction grating of concentric annular grooves is considered for focusing the radiation in an optical waveguide upon excitation of the latter, such a replacement resulting in a smaller size and a higher reliability of optical receivers. The performance of such a grating, dependent on the angle of radiation incidence, is analyzed for the purpose of design optimization. Calculations are made for the specific case of a planar dielectric waveguide diffractively excited by a light beam normally incident on the focusing grating. The analysis is simplified by considering first the reverse process, namely diffractive emission of axisymmetric surface waves coaxially diverging from the center of a sinusoidally corrugated waveguide grating upon excitation by a parallel light beam, and by establishing a degree of analogy with the performance of a grating of rectilinear grooves. The results of the analysis in the appropriate system of cylindrical coordinates are then extended to plane incident waves and the dimensional relations established on this basis yield the dependence of the optimum grating width on its inside radius. Figures 3; references 10: 5 Russian, 5 Western.

**A Violet SiC-4H-LED**

18600151a Leningrad *FIZIKA I TEKHNIKA POLUPROVODNIKOV* in Russian Vol 23 No 1, Jan 89 pp 39-42

[Article by V. A. Dmitriev, L. M. Kogan, Ya. V. Morozenko, B. V. Tsarenkov, V. Ye. Chelnokov, A. Ye. Cherekov]

[Abstract] This study reports the fabrication and specifications of a violet SiC-4H light emitting diode. The LED SiC-4H p-n-structure was fabricated by epitaxial deposition of a 4H p<sup>+</sup> silicon carbide layer onto n-SiC-4H oriented single crystal substrates. The substrates contained nitrogen (the donor); the p<sup>+</sup> layer was doped by aluminum (the acceptor). The SiC substrates were submerged in an Si-C melt solution containing 10 percent Al by weight in order to grow the p<sup>+</sup> layer. Solid aluminum contacts 350 mcm in diameter were then applied to the p-surface of the fabricated epitaxial structure with a mesostructure then developed by reactive ion-plasma etching. Electrical and electroluminescent characteristics were measured on a single p-n-structure in the temperature range 213 to 400 K and in a current range of 0.5 to 100 mA. The electroluminescence spectral maximum lies in the violet range. There is also a

near-linear dependence of luminescence intensity on current. The luminous intensity of the LEDs with a radiation directional pattern half-width of 15° is equal to .15 microdynes at 20 mA and 293 K. LED response is of the order of 100 ns.

**The Amphoteric Properties of Germanium in GaAs:Bi**

18600151b Leningrad *FIZIKA I TEKHNIKA POLUPROVODNIKOV* in Russian Vol 23 No 1, Jan 89 pp 44-47

[Article by V. V. Chaldyshev, N. A. Yakusheva]

[Abstract] This study analyzes the influence of bismuth on the concentration of minor donor and acceptor germanium centers based on photoluminescence and electrophysical analysis of epitaxial GaAs:Ge layers grown from the melt in gallium, bismuth, and mixed solutions. The layers were grown by liquid-phase epitaxy onto a semiinsulating gallium arsenide substrate of (100) orientation. All specimens were grown in identical conditions. The charge carrier concentration and mobility were determined by the van der Pauw method at 77 and 300 K on 3 by 4 mm specimens. The photoluminescence studies were carried out at 4.2 and 77 K using the standard technique with resolution of better than .5 MeV at an excitation intensity of approximately 10<sup>21</sup> kV per second per cm<sup>2</sup>. An analysis of the electrophysical and luminescence properties suggested that the n-type conduction of the epitaxial GaAs:Ge, Bi layers for specimens grown from melt-solutions enriched with bismuth is determined by the increasing trapping of germanium donors due to the diminishing gallium concentration in the liquid phase. The high degree of compensation of these layers is evidently due to deep acceptors.

**Radiative Recombination Mechanisms in Nuclear-Doped Gallium Arsenide**

18600151c Leningrad *FIZIKA I TEKHNIKA POLUPROVODNIKOV* in Russian Vol 23 No 1, Jan 89 pp 79-84

[Article by V. A. Bykovskiy, V. A. Giry, F. P. Korshunov, V. I. Utenko]

[Abstract] This article investigates radiative recombination mechanisms and the nature of compensating acceptor centers based on an analysis of the photoluminescence spectra from annealing of nuclear-doped gallium arsenide. Epitaxial layers and bulk GaAs single crystals were used as the materials for nuclear doping. The epitaxial layers were obtained by liquid phase epitaxy with an electron concentration of 1.8 times 10<sup>14</sup> and 1.6 times 10<sup>15</sup> cm<sup>-3</sup>. The n-type bulk semi-insulating crystals were grown by the Czochralski method under a B<sub>2</sub>O<sub>3</sub> layer and doped with Cr<sub>2</sub>O<sub>3</sub>. Analysis of the photoluminescence spectra during the annealing of weakly-doped materials demonstrated that recombination was due to the band-to-band and interimpurity transitions involving the residual carbon acceptors and



the germanium acceptors that form in the nuclear transmutations. The results obtained in the study suggest two possible compensation mechanisms: the amphoteric nature of the germanium impurity resulting from its possible redistribution between the germanium and arsenic sublattices and the possible formation of doping and residual impurities during irradiation and subsequent heat treatments. A shift of the edge photoluminescent band towards the high-energy range from annealing is observed in the highly-doped samples due to transitions to the tunable band of the acceptor states. The study suggests that, as in the case of weakly nuclear doped gallium arsenide the residual carbon impurity interacts with the radiation defects in the samples and possibly with the germanium and selenium impurities.

### Properties of Epitaxial GaAs Layers Grown on Germanium Substrates

18600151d Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian  
Vol 23 No 1, Jan 89 pp 166-168

[Article by V. A. Bykovskiy, T. I. Kolchenko, V. M. Lomako, S. Ye. Moroz]

[Abstract] This study employs capacitive spectroscopy and photoluminescence measurements to investigate the level of perfection of epitaxial gallium arsenide layers grown on a germanium substrate (GaAs/Ge compared to the GaAs layers obtained in the same process on gallium arsenide substrates (GaAs/GaAs). Measurements revealed that both types of epitaxial test layers are characterized by a sufficient horizontal doping homogeneity. Two primary radiation bands were observed in the photoluminescent spectra of these structures at 4.2 K. Weak radiation bands of 1.413 and 1.403 eV were detected in the low energy range for the GaAs/Ge structures. The stability of the energy properties of the test structures under irradiation by  $^{60}\text{Co}$  gamma radiation was also compared. The overall experimental data suggest that the test epitaxial GaAs/Ge layers are comparable to layers grown by traditional techniques on GaAs substrates with respect to both electrical and optical properties and high energy particle irradiation and these specimens can be used for manufacturing devices.

UDC 621.376.239

### Acoustooptic Frequency Demodulator

18600188b Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian Vol 34 No 3, Mar 89 pp  
628-631

[Article by N. S. Vernigorov and A. V. Pugovkin]

[Abstract] The performance of an acoustooptic frequency demodulator operating with an almost rectangular spectral window and with an almost  $\sin x/x$  intensity distribution of the incident electromagnetic field in the direction of sound wave propagation in the modulator is analyzed on the basis of theoretical estimates and

experimental data. The entire acoustooptic device consists of a modulator with a piezoelectric transducer between two biconvex lenses in their common focal plane, a diaphragm with a rectangular slit passing light from a monochromatic source in the focal plane before the Fourier transforming first lens, and two photodetectors with space band and frequency discriminator each in the focal plane behind the inverse-Fourier transforming second lens. The light intensity distribution in the plane of the photodetectors is calculated from the equation of a generalized acoustooptic spectrum analyzer and the equation of a biconvex lens, this distribution representing the frequency characteristic of an acoustooptic filter. This characteristic and also the discrimination characteristic were calculated on this basis. They were also measured, using an LGN-75 laser with a nominal power of 2 mW and an acoustooptic modulator with a 5-8 pct diffraction efficiency. Diffracted light signals were recorded with a p-i-n photodiode connected to a wideband video amplifier. The detector was found to be linear within 2.5-3.2 pct depending on the acoustic aperture of the modulator. The authors thank G. A. Kolchina for performing calculations on a computer. Figures 4; references 6: 5 Russian, 1 Western (in Russian translation).

### A Differential Counter Control Timer

18600222a Moscow PRIBOERY I TEKHNIKA  
EKSPERIMENTA in Russian No 1, Jan 89 pp 110-111

[Article by A. A. Galitskas]

[Abstract] This article reports a modification on an existing time design used to measure circular polarization of light. In this system the time intervals are determined by square-wave pulses produced by frequency doubling of an external sync signal, subsequent amplification and clipping. Such a timer has inherent systematic errors due to nonlinear distortions and temperature drift and hence this article focuses on methods of modifying the timer design to improve accuracy and stability. The error is found to depend on the difference of the intervals measured by the timer at the initial and final observation times, while the instabilities arising during the observation interval have no effect on the error. The error can be then reduced to the desired level by extending the observation interval. Using these techniques the article develops a highly-precise externally-synchronized timer producing a series of pulses of equal duration, which is resistant to slow perturbations. The device is designed for controlling a differential counter.

### An Automated Multichannel Optical Signal Measurement System for Rapidly Oscillating Signals

18600222g Moscow PRIBOERY I TEKHNIKA  
EKSPERIMENTA in Russian No 1, Jan 89 pp 174-178

[Article by V. G. Brovchenko, A. M. Kirichenko, A. V. Mitrokhin, V. V. Seregin, Yu. A. Tarabrin, M. M. Tsygankov]

[Abstract] This article describes a 30-channel automated recording system for recording signals produced by a photoelectron multiplier. The system employs new photoelectron signal detectors with enhanced bias voltage stability and lower conversion error. The signal detectors integrate the photoelectron multiplier current pulses and store a voltage proportional to the pulse charge. The signals stored in the 30 detectors are alternately transmitted to the analog-to-digital converters in the gaps between the laser pulses by employing two 16-channel switchers. The signal codes are stored in buffer memories. The entire system contains 30 photoelectron pulse detectors, two 16-channel switches, two nine-bit analog-to-digital converters, and two buffer memories. The interrogation time of the 30 channels is less than 50 mcs. The study provides timing diagrams for detector operation as well as a block diagram of the 16-channel switching unit. This system is used to investigate the temporal evolution of plasma parameters by means of Thomson scattering on the OGRA-4 installation at the Institute of Atomic Energy.

**Optimization of an FEU-144 Strobed Photomultiplier for Recording Nanosecond Radiation Pulses Against a High-Intensity Light Background**

18600222h Moscow PRIBOERY I TEKHNIKA  
EKSPERIMENTA in Russian No 1, Jan 89 pp 178-179

[Article by Yu. V. Pisyak]

[Abstract] This article analyzes the performance and function of strobed FEU-144 photomultipliers used to record pulsed radiation against a high-power light background. The strobe parameters of the photomultiplier were optimized on a test stand. The optimum duration and amplitude of the strobe pulses were determined for photomultiplier operation in linear conditions. The range of supply voltages in which linearity of the response was maintained was identical for photomultiplier operation with and without strobing. An optimum supply voltage range was obtained from the experimental data.

**The Effect of High-Power Pulsed Luminous Fluxes on the Sensitivity of Ag-O-Cs Photocathodes**

18600244b Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian  
Vol 34 No 5, May 89 pp 1100-1104

[Article by S. V. Zharkov, V. I. Petrov, O. A. Prikhodko, G. K. Filkin]

[Abstract] This study is devoted to an analysis of the effect of powerful pulsed light on the sensitivity of silver-oxygen-cesium photocathodes and determines that such pulsed light fluxes have a substantial effect on the performance of such a cathode and further can be used as one method of improving its sensitivity. The

study focuses on the photocathodes used in single-chamber industrially-manufactured image converters. These cathodes were irradiated by high-power pulsed light in optical chambers. The energy, temporal and spectral properties of the radiation were varied during the experiments. The energy density incident on the photocathode was varied over a 1 to 100 J/cm<sup>2</sup> range with the square wave radiation pulse duration ranging from .15 to 3 sec. It was found that a substantial improvement in photocathode sensitivity could occur in pulsed irradiation in such conditions and that such an improvement was irreversible. This phenomenon was observed when the photocathode was irradiated by radiation with an energy density exceeding a specific threshold level and the improvement in integral sensitivity was most substantial when this threshold level was initially low. The study also identified certain other features of high-power light irradiation of photocathodes. The study found that in addition to sensitivity improvements proper selection of irradiation conditions could serve to reduce the dark current relative to its initial value. The potential difference between the anode and cathode during irradiation was also found to have no effect on the dependence of sensitivity on the irradiation parameters. High-power pulsed light irradiation was therefore found to be one method of enhancing the sensitivity of He-O-Cs photocathodes due to the following mechanisms associated with heating of the component parts of the cathods: enhanced contact between the cesium oxide and silver particles; covering of certain silver areas by a cesium oxide film; optimization of photocathode structure and an optimum relation between the primary components of the photocathode in the subsurface layer.

**A Filter Based on Surface Acoustical Wave Stepped Interdigital Converters**

18600244c Moscow RADIOTEKHNIKA I  
ELEKTRONIKA in Russian  
Vol 34 No 5, May 89 pp 1104-1107

[Article by A. S. Bagdasaryan, G. Ya. Karapetyan, V. F. Kazennov]

[Abstract] This study proposes fabrication of experimental prototypes of surface acoustical wave bandpass filters based on stepped interdigital converters with appropriate amplitude-frequency responses. Two filters with a nonapodized and apodized stepped interdigital converter at a 426 MHz central frequency were calculated and fabricated on a YZ-LiNbO<sub>3</sub> substrate. In both cases the stepped interdigital converters contain 31 electrodes 36 mcm in length, each with 10 steps corresponding to 310 surface acoustical wave sources. The stepped converter excited surface acoustical waves at the nineteenth harmonic. The output interdigital converter was a nonsectional converter of identical aperture and 41 electrodes with an interelectrode gap of 4 mcm. The study provides the amplitude-frequency responses of these filters and reports a 21.5 dB loss level without matching into a 50 ohm circuit. The

nonuniformity of the amplitude frequency response within the transmission band was less than 0.5 dB. The preliminary experimental results discussed in this article support the promise of stepped converters as base elements for surface acoustical wave microwave

filters, since the minimum dimensions of such converters are substantially larger compared to the interdigital converters presently used: electrode width is increased by a factor of 18 while the interelectrode gap doubles.

UDC 537.521.7

### Mechanism of Breakdown in Inverted Coaxial Diode With Magnetic Shielding

18600063b Leningrad ZHURNAL TEKHNIЧЕСКОЙ ФИЗИКИ in Russian Vol 58 No 8, Aug 88 pp 1584-1586

[Article by I. I. Vintzenko, A. S. Sulakshin and V. I. Tsvetkov, Scientific Research Institute of Nuclear Physics at Tomsk Polytechnic Institute imeni S. M. Kirov]

[Abstract] An experimental study of an inverted coaxial diode with magnetic shielding was made, concerning the effect of processes in the anodic plasma on the life of such a shielding. The cathode, 70 mm in diameter, was made of stainless steel. The anode was 50 mm in diameter and the collector was 80 mm in diameter, the distance from cathode to collector exceeding 600 mm so as to preclude a short circuit through the collector plasma. Nine different anodes were used, made of C, Al, stainless steel, Cu, brass, Mo, W, W-Re alloy, Pb respectively and thus covering a wide range of physical properties. The vacuum inside the tube, 180 mm in diameter, was at least  $10^{-4}$  torr. A coaxial solenoid around the tube produced a uniform shielding magnetic field with an induction variable up to 2.6 T. A high-voltage pulse of negative polarity was applied to the cathode, its amplitude varied over the 100-400 kV range, and the electron current flowing across the shielding magnetic field to the 50 mm long anode was measured with a shielded shunt. The shielding life was determined at the level of 10 pct pulse amplitude. The dependence of the shielding life as well as of the voltage across the diode and of the current through the gap on the induction of the magnetic field have been established on the basis of these measurements. The results correlate with the hydrogen desorption energy characterizing the various anode materials, considering that as much as two thirds of the current in an inverted diode is carried by protons and only about one third of it by ions of the anode material. The results confirm the hypothesis that flow of an electron current through the shielding magnetic field is attended by emission of high-frequency radiation responsible for desorption and ionization of air and organic impurity molecules at the anode surface, radial motion of the anodic plasma across the gap and thus breakdown of the shield being most likely caused by development of centrifugal instability. Figures 2; tables 1; references 8: 7 Russian, 1 Western.

### Characteristics of Defect Formation in Epitaxial GaAs Layer Containing Isovalent Impurity

18600202a Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 23 No 4, Apr 89 pp 626-629

[Article by T. I. Kolchenko, V. M. Lomako, A. V. Rodionov, and Yu. N. Sveshnikov, Scientific Research

Institute of Application Problems in Physics imeni A. N. Sevchenko and Belorussian State University imeni V. I. Lenin, Minsk]

[Abstract] Defect formation in epitaxial GaAs layers doped with In is analyzed on the basis of experimental data and of known concepts regarding electron traps, addition of In impurity evidently causing a redistribution of deep centers in a GaAs layer. Approximately 0.005 mm thick GaAs layers were grown with use of a chloride from the gaseous phase on  $n^{plus}$ -GaAs:Te substrate plates with  $\langle 100 \rangle$  orientation at 740 deg C temperature. Some were left in the intrinsic condition and others were doped by addition of In to the Ga-source at 830 deg C temperature, the In concentration in the GaAs layers varying over the  $2 \cdot 10^{17}$ - $2 \cdot 10^{19}$  cm $^{-3}$  range and the electron concentration correspondingly varying over the  $5.4 \cdot 10^{14}$ - $3.6 \cdot 10^{15}$  cm $^{-3}$  range. The capacitance-voltage characteristic of all layers was measured with GaAs-Al Schottky-barrier structures, also used for spectroscopy of deep levels by the transient capacitance method, while the dislocation density was monitored. The results reveal three kinds of electron traps, E3 traps being predominant in intrinsic GaAs layers but E2 traps becoming predominant and E3 traps as well as E1 traps receding as the In concentration is increased. This behavior is explained by either elastic interaction of entering isovalent impurity and point defects in an epitaxial semiconductor layer or shift of equilibrium and generation of new defects within the field of isovalent impurity. Figures 2; references 18: 10 Russian, 8 Western.

### Hot Charge Carriers in Narrow-Gap Semiconductors in Strong Electric Field

18600202b Leningrad FIZIKA I TEKHNIKA POLUPROVODNIKOV in Russian Vol 23 No 4, Apr 89 pp 630-635

[Article by G. M. Genkin and A. V. Okomelkov, Institute of Applied Physics, USSR Academy of Sciences, Gorkiy]

[Abstract] Generation of excess charge carriers in a semiconductor in a strong constant electric field is considered, assuming an energy gap wider than the energy of an optical phonon so that radiative recombination cannot occur and Auger recombination determines the lifetime of excess charge carriers while interband transitions balance when the rate of Auger recombination is equal to the rate of impact ionization. The equation which describes the balance of interband transitions together with the two equations of energy balance and electroneutrality yield the parameters of the charge distribution functions, for charges in an electric field, the symmetric parts of these functions being assumed to be describable by Fermi functions with nonequilibrium temperatures and chemical potentials. On this basis are established the necessary conditions for population inversion, namely high mobility of charge carriers and degenerate equilibrium distributions of



charge carriers in the absence of an electric field as well as a semiconductor material with a narrow energy gap. For a semiconductor material which meets these requirements, namely  $n\text{-Cd}_{0.17}\text{Hg}_{0.83}\text{Te}$ , are calculated the field dependence of the electron concentration as well as both electron and hole temperatures, with relaxation of electron energy on optical phonons first ignored and then included, also the frequency dependence of the gain in direct interband transitions and of the absorption coefficient referring to free charge carriers in electric fields of intensity higher than critical corresponding to inversion. They yield a gain of the order of  $10^3 \text{ cm}^{-1}$  at frequencies within the 0.1 eV band in an electric field of approximately 300 V/cm at a temperature of 4.2 K. The authors thank A. A. Andronov for discussion. Figures 4; references 5: 4 Russian, 1 Western.

### Effect of Proton Bombardment on Luminescence of GaAs

18600202c Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian Vol 23 No 4, Apr 89  
pp 657-661

[Article by K. D. Glinchuk, N. S. Zayats, and A. V. Prokhorovich, Institute of Semiconductors, UkSSR Academy of Sciences, Kiev]

[Abstract] In an experimental study concerning degradation of GaAs light-emitting diodes by proton bombardment, compensated p-GaAs crystals containing  $2 \cdot 10^{17} \text{ cm}^{-3}$  Zn atoms and  $1 \cdot 10^{17} \text{ cm}^{-3}$  Te atoms as well as uncompensated ones containing only  $1 \cdot 10^{18} \text{ cm}^{-3}$  atoms and fewer than  $5 \cdot 10^{15} \text{ cm}^{-3}$  residual donor atoms were bombarded at 77 K temperature with 0.2 MeV protons in doses up to  $2 \cdot 10^{12} \text{ cm}^{-2}$ . The equilibrium hole concentration in compensated and uncompensated crystals at 77 K was  $2.5 \cdot 10^{16} \text{ cm}^{-3}$  and  $4 \cdot 10^{17} \text{ cm}^{-3}$  respectively, the lifetime of excess electrons was  $10^{-10} \text{ s}$ , the diffusion length for electrons and the mean free path for protons at 77 K being 0.001 mm and 0.0018 mm respectively. Luminescence of crystals was excited by radiation of  $10^{18} \text{ kW/cm}^2 \cdot \text{s}$  from a He-Ne laser, the radiation being strongly absorbed with the characteristic depth  $1/k$  equal to 0.0025 mm. The results indicate that proton bombardment anomalously weakens the 1.5 eV edge emission band shortens the lifetime of excess electrons, the intensity of that emission band depending surprisingly more strongly than the lifetime of excess electrons on the absorbed proton dose. Subsequent annealing of crystals at temperatures not higher than 650 deg C was found to quench the 1.26 eV emission band while enhancing and then quenching both 1.39 eV and 1.18 eV emission bands, quenching of these three bands being evidently caused by annihilation of radiatively or radiatively and thermally generated  $\text{As}_i\text{Zn}_{\text{Ga}}$ ,  $\text{V}_{\text{As}}\text{Zn}_{\text{Ga}}$ ,  $\text{V}_{\text{Ga}}\text{Te}_{\text{As}}$  pairs respectively ( $\text{As}_i$ - interstitial As atoms,

$\text{Zn}_{\text{Ga}}$ - Zn with pinned Ga atoms,  $\text{Te}_{\text{As}}$ - Te with pinned As atoms,  $\text{V}_{\text{As}}$ - As vacancies,  $\text{V}_{\text{Ga}}$ - Ga vacancies). Figures 2; references 12: 6 Russian, 6 Western.

### Effect of Correlation in Impurity Distribution on Edge Luminescence Spectrum of Heavily Doped GaAs

18600202d Leningrad FIZIKA I TEKHNIKA  
POLUPROVODNIKOV in Russian Vol 23 No 4, Apr 89  
pp 693-697

[Article by D. S. Domanevskiy and S. V. Zhokhovets, Belorussian Polytechnic Institute, Minsk]

[Abstract] The distribution of impurity in heavily doped n-GaAs is analyzed for correlation and its effect on the edge luminescence, considering that in the case of a random distribution the probability of an impurity atom found at a distance R from a point defect in the crystal lattice has only one maximum at a distance  $R_m$  inversely proportional to the cube root of the impurity concentration N and in the case of strong Coulomb attraction between point defect and impurity atom this probability has also a second maximum at a distance  $R_0$  inversely proportional to some power of N in addition to the first maximum near  $R_m$  with a minimum between the two. Calculations are shown for GaAs:Te grown by gaseous-phase epitaxy and GaAs:Te grown by the Czochralski method, also for GaAs:Si grown by the Czochralski method. Considering that a steady probability distribution at a temperature not higher than 300 K after a crystal has been cooled corresponds to partial equilibrium, shielding of defect-impurity interaction not only by the very defects and impurity atoms but also by electrons and holes brings the probability distribution in this case closer to a random one. On this basis is then deduced the microstructure of luminescent centers responsible for edge emission, namely a cluster of two or three  $\text{Te}_{\text{As}}$  donors pinned by a  $\text{V}_{\text{Ga}}$  (Ga vacancy) defect. Luminescence measurements at 80 K temperature have validated this model and have yielded quantitative data, namely the dependence of distance  $R_0$  on the impurity concentration N. This distance was found to be smaller in a Czochralski crystal than in an epitaxial one and its dependence on the impurity concentration was found to be much stronger for Si ( $N^{-1}$ ) than for Te ( $N^{-1/8}$ ), evidently owing to amphotericism of Si. With an impurity concentration of  $10^{18} \text{ cm}^{-3}$ , the distance  $R_0$  was 2.36 nm in a Czochralski GaAs:Te crystal, 3.66 nm in an epitaxial GaAs:Te crystal, and 6.0 nm in a Czochralski GaAs:Si crystal. Annealing at temperatures from 800 deg C to above 1000 deg C decreased distance  $R_0$  appreciably, annealing at 1000 deg C already so much that formation of a stable chemical bond compounded Coulomb interaction. Figures 3; references 15: 9 Russian, 6 Western (1 in Russian translation).



### Quasioptic Ferrite Devices

18600226d Gorkiy IZVESTIYA VYSSHIKH  
UCHEBNYKH ZAVEDENIY. RADIOFIZIKA  
in Russian Vol 32 No 4, Apr 89 pp 502-509

[Article by A. A. Kostenko, G. I. Khlopov]

[Abstract] This study analyzes the fundamental operational principles of quasioptic ferrite devices based on the Faraday effect. Such issues as conversion losses in a quasioptic waveguide with a longitudinally-magnetized ferrite element, ferrite element matching in a quasioptic circuit, and quasioptic devices based on multilayered ferrite structures are discussed. The study determines that conversion losses in ferrite elements from the conversion of a quasioptic waveguide field to the upper order modes and reflection losses may reach substantial levels and these in turn depend on the electrodynamic characteristics of the system, which is the primary area of improvement for enhancing the performance of the devices overall. The analysis reveals that losses attributable to field conversion can be substantially reduced by placing a plane parallel ferrite element normal to the waveguide axis. The study proposes ferrite elements in a design representing tuned Fabry-Perot gyrotropic structures that are independently tuned for the orthogonal circularly-polarized field components, thereby allowing complete matching of the elements in the quasioptic circuit. The study also analyzes a variety of quasioptic prototypes based on multilayered ferrite structures and these analyses confirm the possibility of

using the proposed method of matching gyrotropic structures as well as the suitability of the geometry of the device employing plane-parallel ferroelectric elements normal to the quasioptic waveguide axis.

### External Capacitive Characteristics of a Coaxial Cavity for Nondestructive Local Measurement of the Permittivity of Integrated Circuit Films and Substrates

18600249b Sverdlovsk DEFEKTOSKOPIYA in Russian  
No 6, Jun 89 pp 26-34

[Article by V. G. Duving, T. D. Lepilova, M. G. Medoks,  
Yu. P. Naumenko]

[Abstract] This study focuses on an analysis of the external capacitive properties of a coaxial resonator with various conductor types along the open end by modeling and comparison to results obtained from analytic relations and experimental data. The study develops an algorithm for calculating the external capacitance of the coaxial resonator and includes the algorithm program text. The external capacitive components of the coaxial cavity with cylindrical conductors are then calculated based on this modeling routine and algorithm. The analysis identified the factors responsible for the sensitivity of the coaxial cavity and established that the external capacitance rises as a quasilinear function of the permittivity and in proportion to the permittivity with a proportionality factor of less than one.

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